Clean Sustainable Energy Authority

North Dakota Industrial Commission

Application

Project Title: Front-End Engineering and Design for CO_2 Capture at Coal Creek Station

Applicant: Energy & Environmental Research Center

Date of Application: November 1, 2021

Amount of Request
Grant: $7,532,600
Loan: $0

Total Amount of Proposed Project:
$15,065,200

Duration of Project: 18 months
(January 1, 2022 – June 30, 2023)

Point of Contact (POC): Jason D. Laumb

POC Telephone: (701) 777-5114

POC E-Mail: jlaumb@undeerc.org

POC Address: 15 North 23rd Street, Stop 9018

Grand Forks, ND 58202-9018

TABLE OF CONTENTS

Abstract	**4**
Project Description	**5**
Standards of Success	**9**
Background/Qualifications	**9**
Management	**12**
Timetable	**13**
Budget	**14**
Tax Liability	**15**
Confidential Information	**15**
Patents/Rights to Technical Data	**15**
State Programs and Incentives	**15**
References	**17**
Confidential Information Request (confidential)	**Appendix A**
Mitsubishi Heavy Industries and Burns & McDonnell Proposals (confidential)	**Appendix B**
Letters of Support	**Appendix C**
Qualifications of Key Personnel	**Appendix D**
Budget Notes	**Appendix E**
Business Plan (confidential)	**Appendix F**
Historical Financial Statements	**Appendix G**
Budgeted Projections (confidential)	**Appendix H**

ABSTRACT

Objective: The objective of this project is to support the Clean Sustainable Energy Authority (CSEA) goal that focuses on the deployment of large-scale commercial projects that reduce environmental impacts and increase sustainability of energy production and delivery. To support this objective, the project team proposes to complete a FEED (front-end engineering and design) study on the addition of a full-scale postcombustion CO_2 capture system (CCS) that will capture 95% of CO_2 emissions at the 1100-MWe Coal Creek Station, located between Washburn and Underwood, North Dakota. The proposed project will enhance technology based on lessons learned by key project team members at the Petra Nova facility and deploy the lowest-cost next-generation CCS design. Building on the findings of a pre-FEED study for Coal Creek Station, the key deliverables of this FEED study will be a) design, costing, and performance data needed to initiate project financing activities; b) engineering and material balances required to file for all project permits; and c) a final project schedule. The project team proposes to advance capture technology by enhancing the following: 1) steam cycle integration with advanced heat recovery to improve energy efficiency, 2) an integrated solution for aerosol emissions to improve the environmental and operating costs, 3) design of the world's largest capture facility (9.0 million tonnes/yr, representing 19% of CO_2 from North Dakota's stationary sources), and 4) engineering for cold climate performance. This proposal focuses on the capture component, a separate submission on the storage facility is forth coming.

Expected Results: This project will perform process studies requisite for construction and commercial operation of a process unit at the Coal Creek Station capable of capturing 95% plant CO_2 emissions. The studies will establish a design basis and cost estimate possessing sufficient detail to support a final investment decision and immediate procurement of critical, long lead-time equipment whose costs are especially susceptible to price increases. Additionally, the study will generate plans and gather information to enable timely permitting and execution of engineering, procurement, and construction of the facility. Ultimately, the study will reduce the technological and economic risks associated with investing in a postcombustion capture retrofit project while providing information and learnings that will enable similar North Dakota facilities to evaluate deploying such technology to reduce CO_2 emissions. The project team aims to serve as an example of how North Dakota can deploy a technology to reduce CO_2 emissions, improve the marketability of electricity, produce a high-quality CO_2 stream suitable for enhanced oil recovery sales, and pursue Governor Bergum's goal of carbon neutrality by 2030.

Duration: 18 months (January 1, 2022 – June 30, 2023)

Total Project Cost: The proposed total cost is $15,065,200, with $7,532,600 from the North Dakota Industrial Commission (NDIC) and $7,532,600 in cost share from Rainbow Energy Center, LLC (Rainbow Energy Center).

Participants: The project lead is the EERC, and the project will be conducted in partnership with NDIC through the Clean Sustainable Energy Authority, Rainbow Energy Center, Mitsubishi Heavy Industries (MHI), Kiewit, and Burns & McDonnell.

PROJECT DESCRIPTION

Objectives: The objective of this project is to support the Clean Sustainable Energy Authority (CSEA) goal that focuses on the deployment of large-scale commercial projects that reduce environmental impacts and increase sustainability of energy production and delivery. To support this objective, the project team proposes to complete a FEED (front-end engineering and design) study on the addition of a full-scale postcombustion CO_2 capture system (CCS) that will capture 95% of CO_2 emissions at the 1100-MWe Coal Creek Station, located between Washburn and Underwood, North Dakota. The proposed project will enhance technology based on lessons learned by key project team members at the Petra Nova facility and deploy the lowest-cost next-generation CCS design. Building on the findings of a pre-FEED study for Coal Creek Station, the key deliverables of this FEED study will be a) design, costing, and performance data needed to initiate project financing activities; b) engineering and material balances required to file for all project permits; and c) a final project schedule. The project team proposes to advance capture technology by enhancing the following: 1) steam cycle integration with advanced heat recovery to improve energy efficiency, 2) an integrated solution for aerosol emissions to improve the environmental and operating costs, 3) design of the world's largest capture facility (9.0 million tonnes/yr, representing 19% of CO_2 from North Dakota's stationary sources), and 4) engineering for cold climate performance. This proposal focuses on the capture component, a separate submission on the storage facility is forth coming.

Methodology: The following tasks outline the proposed FEED study as the next phase in the necessary due diligence process in project development. The study is scoped such that the project will be able to begin construction by December 31, 2025, a requirement for 45Q tax incentives. The methods in the proposed FEED study will establish and define the technical scope of work and project execution in sufficient detail to determine project cost and develop firm EPC (engineering, procurement, and construction) pricing and detail development schedule for continued development with a trajectory to be eligible for 45Q tax incentives. Four tasks have been identified to execute this work. Additional detail can be found in Appendix B, which contains proposals from Mitsubishi Heavy Industries (MHI) and Burns & McDonnell.

Task 1.0 – Project Management and Planning: The planning and management of all project activities will be performed by EERC personnel over the duration of the project period of performance. This task includes communication of project activities and direction with the project team to provide updates and obtain inputs to prioritize the project focus. Specific activities will include task coordination, risk management/mediation, managing budget resources and subcontractors, the preparation of quarterly progress reports according to NDIC requirements, the preparation of a comprehensive final report, securing cost-share dollars, and planning and executing project status meetings.

Travel is included in the project budget to allow project review meetings in Bismarck, Houston (MHI), and Kansas City (Burns & McDonnell). In addition, this task will include facilitating the involvement of an NDIC designee, as available, in project meetings. Results of all tasks will be provided in project meetings and reports. All additional deliverables noted in the following tasks will be summarized in all quarterly and final reports.

Task 2.0 – Engineering and Design: This task will focus on the engineering and design of the CCS and balance of plant (BOP) integration. The technical project team completed a pre-FEED study under a separate effort, which will be used to guide the team during this FEED study. This task has been divided into four subtasks as follows.

Subtask 2.1 – Project Design Basis: Project leads from each discipline will work together to determine the design basis for this project based on the pre-FEED study and additional studies related to utility optimization, permit requirements, and placement of the facility. This subtask will result in a design basis manual that will be used to guide the team for the duration of the FEED study. In order to set design parameters, stack sampling will be required at Coal Creek Station.

Subtask 2.2 – Carbon Capture System Design: In this subtask, the team will design major components of the carbon capture system based on the design manual parameters identified in the previous subtask. This will include design of the CO_2 capture technology in the CCS island, structure, piping, electrical design (power distribution center), and design of structural/building steel. Findings from this subtask will be used in the overall BOP design in Subtask 2.4, including piping and instrumentation diagrams (P&IDs), equipment data sheets, a piping terminal point list, and general arrangement drawings. The technology vendor will use a separate construction EPC to aid with the civil/earthwork in this portion of the project.

Subtask 2.3 – Steam Cycle Integration: This proposed project will include integration of the CCS island into the Coal Creek Station stream cycle. Under this subtask, the steam turbine will be analyzed by the turbine manufacturer to determine the feasibility and optimize steam extraction and the associated costs. The overall steam cycle will be evaluated to determine the optimal configuration to minimize the cost of carbon capture and maximize system efficiency.

Subtask 2.4 – BOP Integration and Design: This subtask includes all design activities needed to integrate the CCS island into the Coal Creek Station. Design components include the following: 1) civil/earthwork; 2) foundation design; 3) ductwork from existing stack to CCS boundary; 4) cooling system design; 5) BOP piping to and from the CCS boundary; 6) auxiliary buildings for maintenance/warehouse, administration, control room, laboratories, and BOP equipment; and 7) power distribution center, associated electrical distribution, and others. The design package will include general arrangement drawings; process flow diagrams; heat and material balances; P&IDs; a tie-in list; an equipment list; and preliminary structural, civil, and architectural drawings. A hazardous operations (HAZOP) review of the design will be conducted on the high energy portions of the capture system and BOP with applicable National Fire Protection Association (NFPA) codes and standards.

Task 3.0 – Development of Permitting Strategies: This subtask will use all past information collected in previous studies as well as the proposed FEED effort to develop the permitting strategy. The project will not involve actual filing of permit applications but will focus on identification of the permits necessary for construction and moving forward with operation of the project if constructed. Construction activities will require compliance with air, water, and waste product regulations, as described below.

Subtask 3.1 – Air Emissions: Air emissions at Coal Creek Station are regulated by the ND Department of Environmental Quality (NDDEQ). The approval process will begin with a review of existing permits for the existing Coal Creek Station and by organizing a preapplication meeting with NDDEQ. This meeting is necessary to discuss the project details and any requirements for air permitting that may be necessary. Based on this meeting, the project team will gather information and provide the data necessary to move forward.

The team does not anticipate an increase in plant capacity; therefore, a prevention of significant deterioration (PSD) netting analysis will not be required. The CO_2 absorber will likely be considered a new major emission source because of its potential to release trace amounts of amine solvent and degradation by-products (i.e., aldehydes), classified as VOCs (volatile organic compounds). Based on the results of the pre-FEED, air dispersion modeling will be necessary on the absorber stack.

Subtask 3.2 – Water Discharge: This subtask will address National Pollutant Discharge Elimination System (NPDES) permits that are required prior to project construction and operation. These permits include a permit for storm water discharges from construction activities from NDDEQ. The team will also prepare a storm water pollution prevention plan (SWPPP), containing a project description and location, best management practices (BMPs), type and location of erosion and sediment control structures, revegetation requirements, and good housekeeping plans.

The Coal Creek Station is currently a zero-liquid-discharge facility. If the FEED indicates that discharges of industrial wastewater will be needed, the team will modify its NPDES permit for industrial wastewater discharge through NDDEQ.

Subtask 3.3 – Waste Disposal Planning: The proposed carbon capture process produces small amounts of waste, such as solid particulates scrubbed from the flue gas, as well as small quantities of used solvent that may require special disposal procedures. The properties of these and other solid waste streams identified in the FEED study will be identified to plan for proper disposal.

Task 4.0 – Cost Estimating: A cost estimate will be prepared that reflects a strategy to go directly into procurement activities (focus on long-lead equipment) and informing a final investment decision (FID). Standard cost estimating processes include quantify takeoffs and price quotes from vendors for the majority of the equipment and commodities. Components developed in the FEED that are vital to this task include 1) P&IDs; 2) one-lines; 3) detailed and budgetary specifications for major equipment and vendor quotes; 4) general arrangement drawings; 5) project design manual; 6) MTOs (material take-offs) by discipline; 7) indicative pricing from fabricators; 8) construction costs and indirect costs, including engineering, construction management, and home office (procurement and project controls); and 9) contingency and escalation costs assigned depending on the detail of the project quotes. A project execution schedule will also be prepared that includes engineering, procurement, and construction as the project moves forward.

Anticipated Results: The project results will support the mission of the CSEA to develop and deploy large-scale commercial projects that reduce environmental impacts and increase the sustainability of energy production. Results will support advancement of the current state of the art to include 1) steam cycle integration with advanced heat recovery to improve energy efficiency, 2) a solution for aerosol emissions and solvent degradation to improve the environmental and cost profile, 3) design of the world's largest capture facility (9.0 million tonnes/yr representing 19% of CO_2 from North Dakota's stationary sources) to capture greater economies of scale, 4) optimization for cold climate performance, and 5) establishment of the lowest levelized cost of capture attempted at the commercial scale. Deliverables will include a design basis and permitting strategy that would result in a cost estimate possessing sufficient detail to support an FID and immediate procurement of critical, long lead-time equipment whose costs are especially susceptible to price increases.

Facilities: The EERC has over 254,000 square feet of facilities for technology demonstration, process modeling, and project execution. EERC modeling activities will be performed with existing computing facilities and Aspen simulation software. Subcontractors Kiewit, Burns & McDonnell, and MHI maintain office and computing facilities in Lenexa, Kansas; Kansas City, Kansas; and Houston, Texas, respectively. Rainbow Energy Center maintains offices in Bismarck, North Dakota, and at the Coal Creek Station between Underwood and Washburn, North Dakota.

Resources: A team of industry experts will perform all project activities, with the primary project administrative services provided by the EERC. For over 70 years, the EERC has conducted research,

testing, and evaluation of fossil and renewable fuels, emission control technologies, and CCS technologies. The engineering and scientific research staff is equipped with state-of-the-art analytical, modeling, and engineering facilities to address a wide variety of energy, environmental, and mineral resource research topics. The EERC is committed to providing all necessary personnel and resources to ensure the timely completion of all activities outlined in this proposal. Industry sponsor and future plant owner Rainbow Energy Center will provide additional project advisory services. Additional strength is added to the project team by technology owner (MHI), CCS island construction lead Kiewit, and owner engineer (Burns & McDonnell) participation. MHI, Kiewit, and Burns & McDonnell have been a part of project teams that have executed similar project scopes of work focused on North Dakota utilities. MHI and Kiewit bring experience gained from design and construction of the 240-MW system at the Petra Nova facility in Texas as well as another dozen commercial projects around the world.

Techniques to Be Used, Their Availability, and Capability: The primary technique for data generation under this project will be to use recognized and generally accepted good engineering practices and costing techniques for FEED-level efforts. The individual partners and subcontractors mentioned within the proposed project represent decades of experience in CO_2 capture and coal plant operations. All project participants have committed the necessary resources to execute this project, as evidenced by the letters of support in Appendix C. These same industry experts have been a part of several pre-FEED and FEED projects on similarly sized systems within the state of North Dakota. MHI, along with Kiewit, delivered Petra Nova (240 MW) in North America.

This project will also update the performance and economic modeling projections utilizing specific data for the Coal Creek Station. MHI will utilize proprietary design software and PRO II as the primary modeling tool. Aspen software is a comprehensive process simulation tool and has modules to evaluate economics, kinetics, and heat and material balances for complex processes.

Environmental and Economic Impacts While Project Is under Way: The proposed work is a paper study that will not pose any environmental or economic impacts to the study area or partner facilities. The EERC and/or other project partners plan to visit the Coal Creek Station to examine existing facilities and collect data required for design of the CO_2 capture process.

Ultimate Technological and Economic Impacts: The lignite-fired power plants in ND present an opportunity to economically demonstrate the large-scale feasibility of CCS for the existing domestic coal fleet, as they are optimally located near both appropriate geologic storage and fields amenable to enhanced oil recovery (EOR) operations. The economic health of the central region of North Dakota is tied to energy jobs in the area. Currently, the lignite industry directly employs 3623 people, with another 9500 indirect employees supported by the industry, accounting for over $5.4 billion in economic impact. Technology advances that continue the responsible use of lignite and bring new industries to the region are critically needed to sustain and grow these jobs. Based on a recent study by the EERC, the economic impact to a state such as ND from development of a new carbon capture and EOR industry would be tremendous if deployed statewide: $2.5 billion to $3.0 billion in annual economic activity, state revenue increased by $160 million per year, and creation of approximately 8000 (Stanislowski et al., 2019) long-term jobs—at Coal Creek Station alone approximately 35 to 40 direct jobs.

This project will determine a FEED-level cost for installing CCS at Coal Creek Station, but it will also provide a basis for evaluating the efficacy of installing CO_2 capture at the proposed scale on the existing domestic coal fleet by providing the critical information needed to support the business case for CCS. With this project, the project team aims to develop a large-scale commercial project that will reduce environmental impacts and increase sustainability of energy production and delivery. This project will

reduce the technological and economic risks associated with investing in a postcombustion capture retrofit project.

Why the Project Is Needed: The 2019 Polar Vortex (which caused severe limitations of wind power generation capacity and natural gas availability) that swept through the Midwest in early 2019 and the 2021 ERCOT challenges are profound reminders of why we need to keep our entire power generation mix on the table; CCS can serve as a long-term solution to carbon emissions, while also providing firm baseload generation to mitigate the impact of intermittent renewables on grid reliability. Ultimately, Coal Creek Station can serve as a model and learning opportunity for the rest of the nation's existing coal fleet and provide baseload power with reduced CO_2 emissions.

The proposed FEED study is the next phase in the necessary due diligence process in project development and will provide information to secure financing for CO_2 capture at the Coal Creek Station. Financing and CCS project business cases continue to be reliant on federal 45Q tax incentive programs that require projects must begin construction by December 31, 2025. Investing in this project ensures that this initiative can successfully move down the project development path and subsequent demonstrations will be better informed and more likely to succeed and make progress toward Governor Burgum's goal of North Dakota carbon neutrality by 2030. The cost of later projects will benefit by being provided key information relating to a FEED study as well as information on specific carbon capture technologies. By seeking a way to cost-effectively use lignite in a carbon-constrained world, this project supports the core mission of the CSEA to develop large-scale commercial projects which reduce environmental impacts and increase sustainability of energy production and delivery.

STANDARDS OF SUCCESS

This project is the next step on the development path for CO_2 capture at Coal Creek Station. Successful outcomes for the project include a design and detailed project cost for 95% CO_2 capture at the Coal Creek Station. The project team's vision is that the project design will have sufficient detail to support an FID and immediate procurement of critical, long lead-time equipment whose costs are especially susceptible to price increases and maintain a timeline required to be eligible for 45Q tax incentives.

Maintaining and adding jobs will also be a key success criterion for long-term implementation of CCS in North Dakota. The power industry and a newly created CCS industry will preserve and gain new jobs as a result the proposed project. If North Dakota can produce a lower-carbon-intensity power product by implementing CCS at utilities, the state will be able to maintain a reliable baseload power source that can be used to complement existing wind/renewable generation in the state, adding thousands of direct, long-term jobs in the process. If the proposed work moves into construction and deployment phases, Coal Creek Station and the Falkirk Mine will keep the current 700 direct/indirect jobs and add approximately 35 to 40 direct jobs. Additionally, short-term construction jobs are likely to be over 2000 direct/indirect jobs.

BACKGROUND/QUALIFICATIONS

Pre-FEED Study: The EERC previously led a retrofit pre-FEED study of installing a CCS system at Coal Creek Station. Project partners included MHI as the technology provider; MHI is also included as the technology provider in this proposed FEED study. MHI is a globally recognized expert in amine-based carbon capture and previously was the technology provider for the Petra Nova project at the WA Parish plant in Texas, which is the world's largest postcombustion carbon capture facility installed on an

existing coal-fueled power plant. The lessons learned from this full-scale experience have proved invaluable for assessing best methods and control technologies for use at Coal Creek Station.

The pre-FEED study for Coal Creek Station included design packages, cost and performance estimates, and a process hazard analysis (PHA) for both the capture facility and for BOP systems, including, among others, the following:

- Flue gas extraction and handling
- Steam extraction and power recovery
- Cooling water supply
- Electrical distribution systems
- Fire protection
- Plant and instrument air
- Process control systems
- Demineralized water supply

The detailed results from this pre-FEED study will act as a solid foundation for the project team to build directly into the proposed FEED study.

Along with the very detailed pre-FEED design package, the EERC independently developed a process model for Coal Creek Station to use for quick analysis of different capture and steam integration options. This model can be used to generate both performance and cost data in a matter of hours to rapidly assess the feasibility of different capture scenarios. This tool will allow the project team to evaluate potential changes to the pre-FEED design at a high level without impacting the project timeline or budget.

Slipstream Capture Testing: Although solvent-based carbon capture is common in gas processing, postcombustion carbon capture from low-rank coal-fired power stations remains a very new technology at the scale proposed in this FEED study. With any new technology, there is always a risk that full-scale performance will not be as expected. The EERC and MHI have previously demonstrated long-term solvent performance at Coal Creek Station using a slipstream system installed on Unit 1 of the plant. During this testing, solvent was sampled weekly and analyzed for a wide variety of materials known to be concerns for solvent degradation. Over the course of more than 2 months of continuous operation, accumulation of these materials was within expected bounds and was not of concern. The solvent performance also remained steady without indications of any significant loss of capture capacity. This experience lends assurance that MHI's KS-1™ and KS-21™ solvent technology is likely to perform as expected at Coal Creek Station and that the unique flue gas from this plant does not contain levels of problematic contaminants that might lead to accelerated solvent degradation.

One key factor that has arisen as a concern for postcombustion carbon capture at coal-fired power plants in recent years is solvent loss to aerosol formation. Although this is not a major source of amine loss in traditional CO_2 capture units for natural gas, the very fine fly ash from coal-fired power plants provides surface area where volatile amines can condense to form submicron aerosols. This aerosol mist is difficult to recover using conventional methods. In flue gas from low-rank coals, this aerosol formation can lead to amine losses that are much higher than would be expected from traditional vaporization losses.

During on-site slipstream testing at Coal Creek Station, the EERC worked with MHI to test MHI's Amine Emission Reduction (AER) technology for minimizing aerosol losses. During operation with the AER unit, amine was below the 0.1-ppm detection limit at the system outlet, and daily sampling of the solvent over the course of more than 2 months of operation showed that amine content was stable

within the expected range. By contrast, during short-term operation with conventional demisting technology, the aerosol and amine content were significantly higher. Moreover, measurements conducted on the same system using a conventional monoethanolamine (MEA) solution and a traditional water wash section showed large increases in aerosol content through the capture system. These results demonstrate that MHI's proprietary combination of solvent and AER technologies are likely to be highly effective at limiting amine losses to aerosols at Coal Creek Station.

Together, the combination of long-term solvent testing and long-term aerosol emission monitoring using the slipstream system provides assurance that MHI's technology is likely to perform as expected at Coal Creek Station. This experience using actual flue gas, solvent, and aerosol control technologies at the site of choice is unique to the EERC and MHI and demonstrates that this team is qualified to conduct a FEED study at Coal Creek Station with a level of assurance in expected performance that cannot be offered by any other group.

Project Team: The EERC will serve as the lead organization for this project, with Jason Laumb as the overall project manager. Jason Laumb, Director of Advanced Energy Systems Initiatives, will focus on ensuring the overall success of the project by providing experienced management and leadership to all activities within the project. Laumb will ensure that the project is carried out within budget, schedule, and scope. Laumb will also be responsible for communication with project partners and EERC project personnel. Other key personnel from the EERC include Joshua Stanislowski (Process Modeling lead), Joshua Strege (Sampling Team lead), and John Harju (Project Advisor). Qualifications of key personnel can be found in Appendix D. An organization chart is shown in Figure 1.

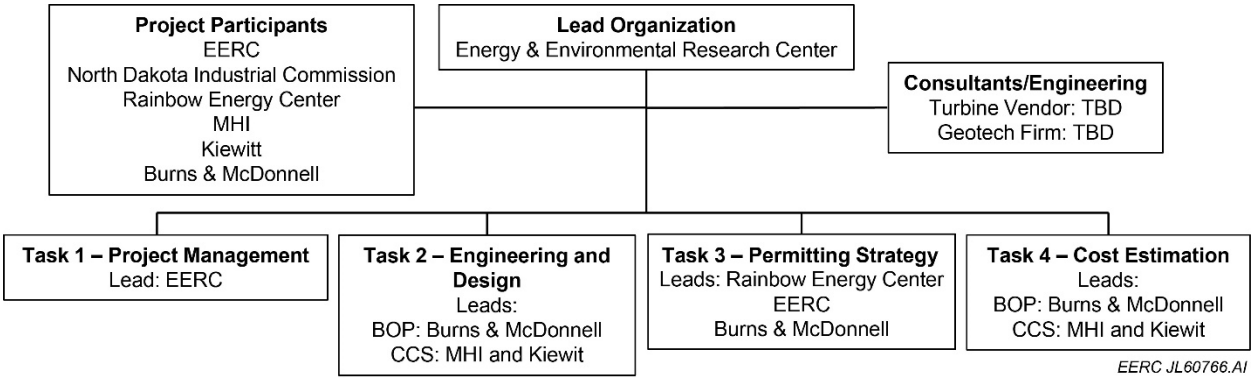

Figure 1. Project organizational chart.

Burns & McDonnell will be responsible for BOP engineering. Burns & McDonnell is a fully integrated engineering, architecture, construction, environmental, and consulting firm with a multidisciplinary staff of more than 7600 professionals. Founded in 1898, its singular mission has been to make its clients successful. Because Burns & McDonnell is relationship-focused and dedicated to creating amazing success for its clients, it has a 90% repeat-business rate and client partnerships that span multiple decades. Being 100% employee-owned means that everyone has an ownership stake in the success of the clients and all team members are driven to find great solutions. Key personnel from Burns & McDonnell include Jeff Schwarz, Project Manager, and Patricia Scroggin-Walker, Carbon Capture Director.

Mitsubishi Heavy Industries America, Inc., and Mitsubishi Heavy Industries Engineering, Ltd., are subsidiaries of Mitsubishi Heavy Industries, Ltd., of Japan (together referred to as MHI). MHI will be

responsible for the CCS scope. Starting in the early 1990s, MHI jointly developed with Kansai Electric Power Company (KEPCO) the proprietary Kansai Mitsubishi Carbon Dioxide Recovery Process (KM CDR Process™) for carbon dioxide removal from combustion gas exhaust streams. MHI's KM CDR Process™ is an amine-based CO_2 capture process which uses MHI's proprietary solvent. The CO_2 capture system is capable of recovering 95% of the CO_2 from the flue gas and compressing the treated CO_2 to adequate pipeline conditions. MHI has provided 13 commercial CO_2 capture systems around the world, including the world's largest postcombustion system capturing 5265 stons/day from a coal-fired power plant in Thompsons, Texas (Petra Nova). Key personnel from MHI include Tim Thomas (Senior Vice President and Deputy General Manager), Shingo Watanabe (Project Manager), and Atsushi Yoshitomi (Engineering Manager).

Rainbow Energy Center, and Nexus Line, LLC, are affiliates of Rainbow Energy Marketing Corporation (REMC). REMC has a history and legacy in North Dakota as part of a family of companies making up United Energy Corporation (UEC). UEC is a diversified energy industry leader in acquiring, drilling, producing, and reworking oil and gas properties, as well as extending that core business into the wholesale buying and selling of natural gas and electricity throughout the United States, Canada, and Mexico. Rainbow Energy Center is currently in the process of purchasing the Coal Creek Station and will be the owner/operator of the facility. Rainbow Energy Center is committed to providing reliable, low-carbon, baseload power to North Dakota and the region. Carbon capture is vital to the success and continued operation of Coal Creek Station. Rainbow Energy Center is committed to delivering carbon capture that serves as a showcase for future projects around the world. Key personnel from Rainbow Energy include Stacy Tschider (President), Jeff Jonson (Executive Vice President), Chris Faul (VP Operations), Lyndsey Roemmich (VP Finance), Ryan Davis (Energy Director), and John Bauer (current Plant Manager).

Kiewit will be responsible for the CCS constructability review and construction estimate. Kiewit Corporation (Kiewit) is one of North America's largest and most respected construction and engineering organizations. With its roots dating back to 1884, the employee-owned organization operates through a network of subsidiaries in the United States, Canada, and Mexico. Kiewit offers construction and engineering services in a variety of markets, including transportation; oil, gas, and chemical; power; building; water/wastewater; industrial; and mining. Kiewit had 2020 revenues of $12.5 billion and employs 27,000 staff and craft employees. Within Kiewit, the Kiewit Engineering Group Inc. (KEGI) has a combined staff of over 2000 engineers and designers across all major engineering disciplines. Over 140 of these are currently performing engineering services on carbon capture projects, including natural gas processing, refining, LNG, cement, steel, ethanol, power projects, and direct air capture. Kiewit has become an industry-leading EPC (engineering, procurement, and construction) contractor for clients seeking new solutions to lower their carbon intensity. Kiewit's experience includes the first commercial-scale postcombustion carbon capture plant in the United States, Petra Nova, where Kiewit completed the EPC scope in 2016. By 2021 year-end, Kiewit will have developed fixed-price estimates for two power-related amine-based carbon capture projects. In early 2022, Kiewit will have a solid sorbent pilot and a direct air capture pilot under construction. Key personnel from Kiewit include Bob Slettehaugh (Manager of Carbon Capture), Alan Donovan (Project Manager), and Bryan Lofgreen (Lead Mechanical Engineer).

MANAGEMENT

The EERC is the lead organization for this project and will oversee all tasks and management activities associated with this project. The EERC will schedule regular internal and external meetings with project staff and advisors to ensure that the project is conducted using acceptable scientific methodologies and

practices in accordance with the project plan (budget, schedule, deliverables, and milestones) and is meeting quality objectives. The EERC will keep all partners informed of project progress and coordinate activities as necessary for the execution of a successful project and will be responsible for timely submission of all project deliverables and transfer of data and products to the team.

Once the project is initiated, the project team will engage in weekly conference calls to review project status and future directions. Quarterly reports will be prepared and submitted to project sponsors for review. Regular meetings will be held to review the status and results of the project and discuss directions for future work. A broad team approach is key to successful execution of this project.

Project progress will be measured by completion of milestones and deliverables as noted in the project timeline in Figure 2. The milestones and deliverables are at key times during the project design, permitting, and costing components of the project. The deliverables are indicated where key design documents and reports are noted, while the milestones are noted as key accomplishments during the project's progress.

TIMETABLE

The project timeline can be found in Figure 2. The project is scheduled for 18 months, with a projected start date of January 2022. The start date may depend on procurement of the Coal Creek Station by Rainbow Energy Center. This timeline is necessary to maintain a schedule that could allow for construction activities to begin by December 31, 2025. The team anticipates FEED reports will be available from MHI and Burns & McDonnell by the end of Month 16 of the project. The FEED reports will then be assembled into a project final report.

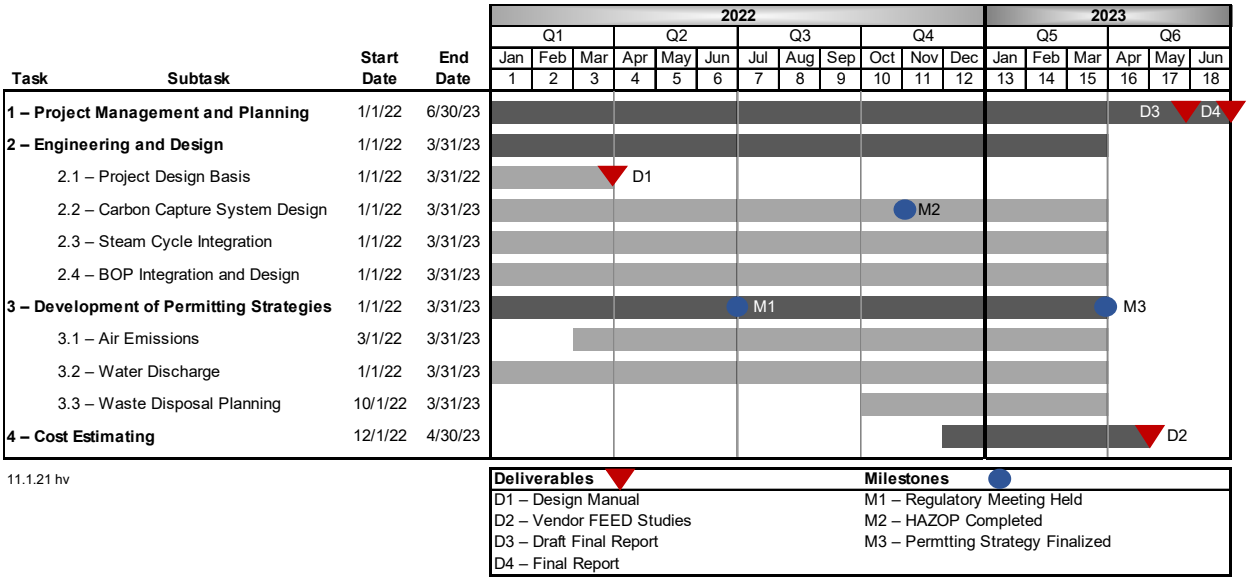

Figure 2. Project Gantt chart.

BUDGET

The proposed budget is $15,065,200, with $7,532,600 from NDIC and $6,767,400 cash and $765,200 in-kind from Rainbow Energy Center. The budget includes significant subcontracts for MHI and Burns & McDonnell. Travel dollars are also included to support sampling trips to Coal Creek Station, to Rainbow Energy Center offices in Bismarck for project review meetings, Kansas City at Burns & McDonnell office for design review meetings, and to MHI facilities in Houston for HAZOP meetings. The detailed breakdown is shown in Table 1.

The budget notes can be found in Appendix E.

Table 1. Estimated Capital Costs

Project Associated Expense	NDIC Grant	NDIC Loan	Rainbow Energy Center Share (Cash)	Total Project
Labor	$1,169,821	$0	$0	$1,169,821
Travel	$12,336	$0	$0	$12,336
Supplies	$5,700	$0	$0	$5,700
Subcontractor - MHI	$2,487,600	$0	$6,767,400	$9,255,000
Subcontractor - B&M	$2,970,000	$0	$0	$2,970,000
Communications	$637	$0	$0	$637
Printing & Duplicating	$2,500	$0	$0	$2,500
Food	$1,000	$0	$0	$1,000
Laboratory Fees & Services				
EERC Analytical Research Lab	$5,667	$0	$0	$5,667
EERC Particulate Analysis Lab	$5,742	$0	$0	$5,742
EERC Graphics Services	$5,562	$0	$0	$5,562
EERC Shop & Operations	$8,454	$0	$0	$8,454
EERC Technical Software Fee	$1,236	$0	$0	$1,236
EERC Engineering Services Fee	$13,630	$0	$0	$13,630
Geotech Firm (TBD)	$25,000	$0	$0	$25,000
Turbine Vendor (TBD)	$100,000	$0	$0	$100,000
Total Direct Costs	$6,814,885	$0	$6,767,400	$13,582,285
Facilities & Administration	$717,715	$0	$0	$717,715
Total Cash Requested	**$7,532,600**	**$0**	**$6,767,400**	**$14,300,000**
In-Kind Cost Share				
Rainbow Energy Center	$0	$0	$765,200	$765,200
Total In-kind Cost Share	**$0**	**$0**	**$765,200**	**$765,200**
Total Project Costs	**$7,532,600**	**$0**	**$7,532,600**	**$15,065,200**

TAX LIABILITY

The EERC, a department within UND, is a state-controlled institution of higher education and is not a taxable entity; therefore, it has no tax liability to the state of North Dakota or any of its political subdivisions.

CONFIDENTIAL INFORMATION

Confidential information is contained in Appendix A, B, F, G, and H.

PATENTS/RIGHTS TO TECHNICAL DATA

MHI holds patents to the KM CDR Process™, KS-1™ solvent, and KS-21™ solvent that will be used as the CCS technology for the proposed work. MHI will retain these patents and ownership rights.

STATE PROGRAMS AND INCENTIVES

The applicant has participated in several programs administered by NDIC, including the Lignite Research Program, the Oil and Gas Research Program, the State Energy Research Center, and the Renewable Energy Program. Table 2 shows funding received by the EERC from these state programs in the last 5 years.

Table 2. Summary of EERC Funding from State Programs

Project Title	Start Date	End Date	Dollar Amount
North Dakota Integrated Carbon Storage Complex Feasibility Study	07/17/17	02/08/20	$1,500,000
Initial Engineering, Testing, and Design of a Commercial-Scale CO_2 Capture System	09/01/17	12/31/19	$3,200,000
Economic Extract. and Recov. of REES and Product. of Clean Value-Added Prods. from Low-Rank Coal Fly Ash	06/16/18	02/15/20	$30,000
Flue Gas Characterization and Testing	07/01/20	11/30/21	$3,741,450
Wastewater Recycling Using a Hygroscopic Cooling System	01/31/20	09/30/22	$100,000
PCOR Initiative to Accelerate CCUS Deployment	02/01/20	09/30/24	$2,000,000
Laboratory-Scale Coal-Derived Graphene Process	09/01/20	04/30/23	$162,500
Ammonia-Based Energy Storage Technology	04/01/21	03/31/22	$101,390
NDIC Emerging Issues	12/12/16	06/30/21	$500,000
Bakken Production Optimization Program 2.0	11/01/16	05/31/20	$6,000,000
Pipeline Study Phase III (HB 1347)	07/01/17	06/30/19	$500,000
iPIPE: The Intelligent Pipeline Integrity Program	04/01/18	12/31/22	$2,600,000
Underground Storage of Produced Natural Gas – Conceptual Evaluation and Pilot Project(s)	06/01/19	06/30/23	$6,000,000
PCOR Initiative to Accelerate CCUS Deployment	02/01/20	09/30/24	$2,000,000
Improving EOR Performance Through Data Analytics and Next-Generation Controllable Completions	01/27/20	09/30/24	$500,000
FERR 3.2 – Produced Water Management Through Geologic Homogenization, Conditioning, and Reuse	02/01/20	01/31/22	$300,000
Bakken Production Optimization Program 3.0	05/01/20	04/30/23	$6,000,000
Field Study to Determine the Feasibility of Developing Salt Caverns for Hydrocarbon Storage in Western North Dakota	07/01/21	06/30/23	
Hydrogen Energy Development for North Dakota	07/01/21	06/30/23	$500,000
Assessment of Bakken and Three Forks Natural Gas Compositions	11/01/19	06/19/20	$300,650
FERR 1.3 Integrated Carbon Capture and Storage for North Dakota Ethanol Production	08/30/16	05/31/17	$490,000
FERR 1.3 Integrated Carbon Capture and Storage for North Dakota Ethanol Production	11/01/17	07/31/18	$345,000
Low-Pressure Electrolytic Ammonia (LPEA) Production	06/16/18	12/31/21	$437,000
FERR 1.3 Integrated Carbon Capture and Storage for North Dakota Ethanol Production	12/01/18	05/31/20	$500,000
EERC Technical Support for RTE CCS Activities – November 1, 2019	06/01/20	11/30/21	$500,000
State Energy Research Center	07/01/19	06/30/23	$10,000,000
		Total	**$48,307,990**

REFERENCES

Stanislowski, J.J.; Folkedahl, B.C.; Jensen, M.D.; Musich, M.A. *Regional Impacts of Carbon Capture and Sequestration in the State of North Dakota*; Final Report for Lignite Energy Council; EERC Publication 2019-EERC-02-07; Energy & Environmental Research Center: Grand Forks, ND, Feb 2019.

APPENDIX C

LETTERS OF SUPPORT

RAINBOW
ENERGY CENTER

North Dakota Industrial Commission
Attn: Clean Sustainable Energy Authority
State Capitol – 14th Floor
600 East Boulevard Ave. Dept. 405
Bismarck, ND 58505-0840

Dear Executive Director Al Anderson and the Clean Sustainable Energy Authority,

Thank you for the opportunity to present the grant proposal for the "Front-End Engineering and Design (FEED) for CO_2 capture at Coal Creek Station" in partnership with The Energy & Environmental Research Center (EERC). Your support of the FEED is critical to the development of this study which will help reach the final steps leading up to construction for post combustion capture and storage at Coal Creek Station.

Rainbow Energy Center is in the process of purchasing Coal Creek Station and will be the owner/operator of the facility in the near future. Rainbow Energy Center is an affiliate of Rainbow Energy Marketing Corporation (REMC), and has a history and legacy in North Dakota, as part of a family of companies making up United Energy Corporation (UEC).

Rainbow Energy Center plans to focus on baseload energy from Coal Creek Station with carbon capture and incremental generation from renewables to fully utilize the capacity of the high-voltage direct current (HVDC) transmission system. Carbon capture and storage is vital to continued operation of Coal Creek Station and is an important step toward Gov. Doug Burgum's goal for the state to reach carbon neutrality by 2030. Implementing carbon capture technology allows fossil fuel to continue to meet the nation's energy demand, while also reducing CO_2 emissions. With proven technology and financial incentives such as the 45Q tax credit, a strong business case exists to partner carbon capture technology at coal-fired electric generation facilities like Coal Creek Station.

As North Dakota's largest power plant, Coal Creek Station supports over 700 jobs – at the plant, Falkirk Mine and other supporting industries. Implementing new technologies saves existing jobs and also creates new jobs and serves as an economic backbone for the area communities, county and state. In support of e Coal Creek Station and these communities, Rainbow Energy Center is committing $6,767,400 cash and $765,200 in-kind funding to this proposed FEED project. Rainbow Energy Center verifies that this committed funding is not being shown as cost share to any other state programs. The cost share dollars are contingent upon the finalized purchase of Coal Creek Station by Rainbow Energy Center.

We believe carbon capture and storage at Coal Creek Station meets the Clean Sustainable Energy Authority's mission to deploy large-scale commercial technologies that produce reliable, dispatchable, low carbon electricity, while also sustaining jobs, tax revenue, and the economic vitality of the state. Rainbow Energy Center is committed to delivering carbon capture that serves as a showcase for future projects around the world. Thank you for your consideration of support for this application.

Kind regards,

Stacy L. Tschider
President

919 S 7th St., Ste. 405 | PO Box 837 | Bismarck, ND 58502 | Phone: 701.222.2290 | Fax: 701.255.7952 | rainbowenergycenter.com

October 15, 2021

Mr. Jason Lamb
Director, Advanced Energy System Initiatives
Energy & Environmental Research Center
15 North 23rd Street, Stop 9018
Grand Forks, ND 58202-9018

Re: Letter of Commitment
Coal Creek Station Carbon Capture FEED Project

Dear Mr. Lamb:

On behalf of Burns & McDonnell, this letter expresses our support and commitment for the Coal Creek Station Carbon Capture FEED Project for which a proposal is being submitted to the North Dakota Industrial Commission.

Burns & McDonnell is a fully integrated engineering, architecture, construction, environmental and consulting firm with a multidisciplinary staff of more than 7,600 professionals. Founded in 1898, our singular mission has been to make our clients successful. Being 100 percent employee-owned means that everyone has an ownership stake in the success of our clients, and all team members are driven to find great solutions.

Burns & McDonnell is committed to making this project a success, and these key factors distinguish our firm from others, enabling the success of this partnership:

- ***Safety Culture:*** For us, safety is a value ingrained in our corporate culture. Our Corporate Safety & Health Program is integrated with our project process and requires pre-planning work activities to support implementation of safe work measures. Every project at Burns & McDonnell operates with the safety philosophy that zero recordable incidents can be accomplished with proper planning, resources, and follow-through. Our project safety records demonstrate the success of this approach.
- ***Commitment to the Project:*** Burns & McDonnell has successfully worked with EERC and MHI on carbon capture Pre-FEED and FEED projects in North Dakota. We have experience with this process and are confident we can continue to be a valuable part of the team on this project and future projects.
- ***Proven Team:*** Burns & McDonnell has worked on various elements of carbon capture projects, from the early stages of feasibility studies through cost estimates and balance of plant design for major mechanical, electrical, process, and structural systems. We have the right team, and the right approach, to tackle each step in the process.

9400 Ward Parkway \ Kansas City, MO 64114
O 816-333-9400 \ F 816-333-3690 \ burnsmcd.com

We appreciate being considered for this project and look forward to participating with Coal Creek staff, EERC, and MHI. If you have any questions or need any additional information, please contact myself or Ron Bryant.

Sincerely,

Patricia (Tisha) M. Scroggin-Wicker, PE
Director of Process Technology
Burns & McDonnell Engineering Company, Inc.

Kiewit

October 22, 2021

Mr. Jason Laumb
Director, Advanced Energy System
Initiatives Energy & Environmental
Research Center
15 North 23rd Street, Stop 9018
Grand Forks, ND 58202-9018

RE: Letter of Commitment for Coal Creek Station CO_2 Capture FEED Study

Dear Mr. Laumb,

Kiewit Engineering Group Inc. (KEGI) is pleased to commit its support to the front-end engineering and design (FEED) study for a CO_2 capture plant retrofit on both Units at Coal Creek Station in North Dakota. This project, in response to the North Dakota Clean Sustainable Energy Authority funding opportunity, has a goal of advancing carbon capture technology in North Dakota.

KEGI and TIC, both Kiewit Corporation companies, partnered with MHIA and MHI to engineer, procure, and construct the Petra Nova Project, the world's largest post-combustion CO_2 capture system (4,776 tonnes/day of CO_2 captured). KEGI provided detailed design of the balance-of plant (BOP or OSBL) and TIC was responsible for construction of both the OSBL and inside-battery limit (ISBL) scope.

KEGI has recent or ongoing experience working on FEED and Pre-FEED studies for post-combustion CO_2 capture totally over 25 million tonne per year of capacity, including several projects with MHI with their proprietary Kansai Mitsubishi Carbon Dioxide Recovery Process (KM CDR Process™) including the use of MHI's proprietary solvent. In all of these studies KEGI has developed the ISBL construction estimate and, in most cases, has also performed the engineering and developed the construction estimate for the BOP.

Our role, as currently identified, is generally limited to the construction estimate associated with the ISBL carbon capture plant components to utilize the advanced MHI capture process, but we open to supporting the project in whatever way brings the most value.

Sincerely,

Matthew Thomas
Senior Vice President Engineering and
Consulting Services
Kiewit Engineering Group Inc.

Engineered Systems Division
Mitsubishi Heavy Industries America, Inc.
•20 Greenway Plaza Suite 600 Houston, TX 77046 Tel: (713)-351-6400 Fax: (713)-351-6450•

October 18, 2021

Mr. Jason Laumb
Director, Advanced Energy System Initiatives
Energy & Environmental Research Center
15 North 23rd Street, Stop 9018
Grand Forks, ND 58202-9018

RE: Letter of Commitment for Coal Creek Station CO_2 Capture FEED Study

Dear Mr. Laumb,

Mitsubishi Heavy Industries America, Inc. (MHIA) is pleased to commit its support to the FEED study for a CO_2 capture plant retrofit on both Units at Coal Creek Station in North Dakota. This project, in response to the North Dakota Clean Sustainable Energy Authority funding opportunity, has a goal of advancing carbon capture technology in North Dakota.

MHIA is a wholly-owned subsidiary of Mitsubishi Heavy Industries, Ltd. (MHI) and together delivered the Petra Nova Project, the world's largest post-combustion CO_2 capture system (4,776 tonnes/day of CO_2 captured) including overall engineering, design, and procurement for all major equipment, operator training, and commissioning support.

MHI has delivered 13 commercial plants for coal, natural gas, and oil combustion exhaust gases and holds an outstanding market share in the world in the field of post-combustion CO_2 capture, leading the world in commercially proven post-combustion CO_2 capture knowledge base. The CO_2 capture system proposed for this project is based on improvements to MHI's proprietary Kansai Mitsubishi Carbon Dioxide Recovery Process (KM CDR Process™) including the use of MHI's proprietary solvent.

Our role involves the responsibility for the detailed engineering, design, and supply of the Inside the Battery Limit (ISBL) carbon capture plant components to utilize the advanced MHI capture process.

Sincerely,

Timothy E Thomas
Senior Vice President & Deputy General Manager
Mitsubishi Heavy Industries America, Inc.

APPENDIX D

QUALIFICATIONS OF KEY PERSONNEL

JASON D. LAUMB
Director of Advanced Energy Systems Initiatives
Energy & Environmental Research Center (EERC), University of North Dakota (UND)
15 North 23rd Street, Stop 9018, Grand Forks, ND 58202-9018 USA
701.777.5114 (phone), 701.777.5181 (fax), jlaumb@undeerc.org

Principal Areas of Expertise

Mr. Laumb's principal areas of interest and expertise include renewable energy, CO_2 capture, techno-economic modeling, extraction of critical materials, environmental control systems, supercritical CO_2 power cycles, and advanced gasification technologies. His experience includes biomass and fossil fuel conversion for energy production, with an emphasis on ash effects on system performance; trace element emissions and control for fossil fuel combustion systems, with a particular emphasis on air pollution issues related to mercury and fine particulates; and design and fabrication of bench- and pilot-scale combustion and gasification equipment.

Qualifications

M.S., Chemical Engineering, University of North Dakota, 2000.
B.S., Chemistry, University of North Dakota, 1998.

Professional Experience

May 2021–Present: Director of Advanced Energy Systems Initiatives, EERC, UND. Mr. Laumb provides leadership on projects related to advanced energy systems and leads a multidisciplinary team of scientists and engineers working on advanced energy technologies from pollution control to new energy platforms.

September 2019–April 2021: Assistant Director of Advanced Energy Systems, EERC, UND. Mr. Laumb assisted the EERC executive team by providing leadership on projects related to advanced energy systems. Mr. Laumb led a multidisciplinary team of scientists and engineers working on advanced energy technologies from pollution control to new energy platforms. Specific areas of interest included CO_2 capture, techno-economic modeling, environmental control systems, supercritical CO_2 power cycles, and advanced gasification technologies. Research activities focused on low-carbon-intensity power cycles for fossil fuel-fired systems.

2008–August 2019: Principal Engineer, Advanced Energy Systems Group Lead, EERC, UND. Mr. Laumb led a multidisciplinary team of 30 scientists and engineers to develop and conduct projects and programs on power plant performance, environmental control systems, the fate of pollutants, computer modeling, and health issues for clients worldwide. Efforts focused on development of multiclient jointly sponsored centers or consortia funded by government and industry sources. Research activities included computer modeling of combustion/gasification and environmental control systems, performance of SCR technologies for NO_x control, mercury control technologies, hydrogen production from coal, CO_2 capture technologies, particulate

matter analysis and source apportionment, the fate of mercury in the environment, toxicology of particulate matter, and in vivo studies of mercury–selenium interactions.

2001–2008: Research Manager, EERC, UND. Mr. Laumb led projects involving bench-scale combustion testing of various fuels and wastes as well as a laboratory that performs bench-scale combustion and gasification testing. He served as principal investigator and managed projects related to the inorganic composition of coal, coal ash formation, deposition of ash in conventional and advanced power systems, and mechanisms of trace metal transformations during coal or waste conversion and wrote proposals and reports focused on energy and environmental research.

2000–2001: Research Engineer, EERC, UND. Mr. Laumb assisted in the design of pilot-scale combustion equipment and wrote computer programs to aid in the reduction of data, combustion calculations, and prediction of boiler performance. He was also involved in the analysis of combustion control technologies' ability to remove mercury and the suitability of biomass as boiler fuel.

1998–2000: SEM Applications Specialist, Microbeam Technologies, Inc., Grand Forks, North Dakota. Mr. Laumb gained experience in power system performance including conventional combustion and gasification systems; knowledge of environmental control systems and energy conversion technologies; interpreting data to predict ash behavior and fuel performance; assisting in proposal writing to clients and government agencies such as the National Science Foundation and the U.S. Department of Energy; preparing and analyzing coal, coal ash, corrosion products, and soil samples using SEM/EDS; and modifying and writing FORTRAN, C+, and Excel computer programs.

Professional Membership
American Chemical Society

Publications and Presentations
Has coauthored numerous professional publications.

JOSHUA J. STANISLOWSKI
Director of Energy Systems Development
Energy & Environmental Research Center (EERC), University of North Dakota (UND)
15 North 23rd Street, Stop 9018, Grand Forks, North Dakota 58202-9018 USA
701.777.5087 (phone), 701.777.5181 (fax), jstanislowski@undeerc.org

Principal Areas of Expertise

Mr. Stanislowski's principal areas of interest and expertise include coal and biomass gasification systems with an emphasis on novel syngas cooling, cleanup, and separation technologies. He has worked extensively with hydrogen separation membrane systems and liquid fuels catalysis. He is proficient in process modeling and systems engineering including techno-economic studies using Aspen Plus software. He has significant experience with process engineering, process controls, and project management. He has a strong background in gauge studies, experimental design, and data analysis.

Qualifications

M.S., Chemical Engineering, University of North Dakota, 2012.
B.S., Chemical Engineering, University of North Dakota, 2000.
Six Sigma Green Belt Certified, August 2004.

Professional Experience

August 2019–Present: Director of Energy Systems Development, EERC, UND. Mr. Stanislowski leads a multidisciplinary team of scientists and engineers focused on research, development, and commercialization of innovative energy technologies as they relate to coal utilization and emissions, carbon management, and alternative fuels and renewable energy. In September 2020, he was named Co-Project Manager of the Intelligent Pipeline Integrity Program (iPIPE) at the EERC, an industry-led consortium whose focus is to contribute to the advancement of near-commercial, emerging technologies to prevent and detect leaks from gathering pipelines.

2015–July 2019: Principal Process Engineer, Energy Systems Development, EERC, UND. Mr. Stanislowski worked closely with the EERC management team to develop new programmatic directions to solve challenges in the energy industry. He managed projects in the areas of gasification, CO_2 capture, supercritical CO_2 power cycles, and systems engineering.

2008–2015: Research Manager, EERC, UND. Mr. Stanislowski managed projects in the areas of gasification, gas cleanup, hydrogen production, liquid fuel production, and systems engineering.

2005–2008: Research Engineer, EERC, UND. Mr. Stanislowski's areas of focus included mercury control technologies and coal gasification. His responsibilities involved project management and aiding in the completion of projects. His duties included design and construction of bench- and pilot-scale equipment, performing experimental design, data

collection, data analysis, and report preparation. He also worked in the areas of low-rank coal gasification, warm-gas cleanup, and liquid fuels production modeling using Aspen Plus software.

2001–2005: Process Engineer, Innovex, Inc., Litchfield, Minnesota.

– Mr. Stanislowski was responsible for various process lines including copper plating, nickel plating, tin–lead plating, gold plating, polyimide etching, copper etching, chrome etching, and resist strip and lamination. His responsibilities included all aspects of the process line including quality control, documentation, final product yields, continuous process improvement, and operator training. He gained extensive knowledge of statistical process control and statistical start-up methodology. Mr. Stanislowski was proficient with MiniTab statistical software and utilized statistical analysis and experimental design as part of his daily work.

– Mr. Stanislowski designed and oversaw experiments as a principal investigator; wrote technical reports and papers, including standard operating procedures and process control plans; presented project and experimental results to suppliers, customers, clients, and managers; created engineering designs and calculations; and performed hands-on mechanical work when troubleshooting process issues. He demonstrated the ability to coordinate activities with varied entities through extensive project management and leadership experience.

1998–2000: Student Research Assistant, EERC, UND. Mr. Stanislowski worked on a wide variety of projects, including data entry and programming for the Center for Air Toxic Metals® (CATM®) database, contamination cleanup program development, using aerogels for emission control, and the development of a nationwide mercury emission model.

Publications and Presentations

Has coauthored several publications.

JOSHUA R. STREGE
Assistant Director for Energy Systems
Energy & Environmental Research Center (EERC), University of North Dakota (UND)
15 North 23rd Street, Stop 9018, Grand Forks, North Dakota 58202-9018 USA
701.777.5080 (phone), 701.777.5181 (fax), jstrege@undeerc.org

Principal Areas of Expertise

Mr. Strege's principal areas of interest and expertise include biomass and fossil fuel conversion for energy production, with an emphasis on CO_2 capture and storage in power generation and in industrial applications. He is certified in Aspen Plus and Aspen HYSYS and is proficient in process modeling and techno-economic assessments. He also has significant experience in the design, fabrication, and operation of bench- and pilot-scale equipment for combustion, gasification, synthetic and renewable fuel production, and CO_2 capture.

Qualifications

M.S., Chemical Engineering, University of North Dakota, 2005. Thesis: High-Temperature Corrosion of Potential Heat Exchange Alloys under Simulated Coal Combustion Conditions.

B.S., Chemical Engineering, University of North Dakota, 2005.

Training: Project Management training through PM College, Six-Sigma Green Belt, and Design Flow Technology (DFT).

Skills: Microsoft Office suite (Excel, MS Project, Word, and Access) and advanced VBA macro programming and SQL server integration; CAD design and engineering drawing creation (PTC Creo Parametric).

Certifications: Aspen Plus- and Aspen HYSYS-certified.

Professional Experience

May 2021–Present: Assistant Director for Energy Systems, EERC, UND. Mr. Strege leads a multidisciplinary team of engineers and scientists in evaluating and demonstrating energy processes from the initial modeling phase through physical testing at the bench, pilot, and demonstration scales. Specific areas of interest include CO_2 capture and transport, process modeling and techno-economic analysis, gasification and combustion technology development and demonstration, and other energy conversion technologies. Current research activities are focused on low-carbon-intensity power cycles for fossil fuel- and biomass-fired systems.

October 2019–April 2021: Principal Process Engineer, Energy Systems Development, EERC, UND. Mr. Strege led the process engineering team in process modeling and techno-economic analysis efforts across applied research projects encompassing CO_2 capture and transport, advanced power cycle technology development, and other energy conversion technologies.

2013–September 2019: Project Manager and Senior Engineer, Cirrus Aircraft. Mr. Strege's responsibilities as Project Manager included building an 80-member team to develop and manufacture composite products for small aircraft under contract with an outside client. As

Senior Engineer, he led a team of engineers and technicians responsible for reducing waste, implementing root cause and corrective actions on product defects and downstream issues, and developing and implementing software solutions for improved tracking and accountability across all departments.

2005–2013: Research Engineer, EERC, UND. Mr. Strege participated in and managed several multiyear, multiclient projects aimed at researching and developing alternative energy and fuel sources. Specific projects included hydrotreating of waste vegetable oils for conversion to drop-in-compatible JP-8 jet fuel, assessing the feasibility of modern warm-gas cleanup technologies for liquid fuel synthesis via the Fischer–Tropsch process, and design and testing of cold-gas cleanup reactors for syngas. He also participated in pilot-scale studies comparing the postcombustion CO_2 capture efficiency of a variety of proprietary and conventional amine-based solvents.

2000–2005: Student Research Assistant, EERC, UND. Mr. Strege's responsibilities included design and development of instrument control software. In addition, he studied corrosion rates and mechanisms of high-temperature alloys as part of his master's research.

Publications and Presentations

Has authored and coauthored numerous professional publications and presentations.

JOHN A. HARJU
Vice President for Strategic Partnerships
Energy & Environmental Research Center (EERC), University of North Dakota (UND)
15 North 23rd Street, Stop 9018, Grand Forks, North Dakota 58202-9018 USA
701.777.5157 (phone), 701.777.5181 (fax), jharju@undeerc.org

Principal Areas of Expertise

Mr. Harju's principal areas of interest and expertise include carbon sequestration, enhanced oil recovery, unconventional oil and gas development, waste management, geochemistry, technology development, hydrology, and analytical chemistry, especially as applied to the upstream oil and gas industry.

Qualifications

M.Eng., Petroleum Engineering, University of North Dakota, 2020.
B.S., Geology, University of North Dakota, 1986.

Professional Experience

2002–Present: EERC, UND.

July 2015–Present: Vice President for Strategic Partnerships. Mr. Harju leads efforts to build and grow dynamic working relationships with industry, government, and research entities globally in support of the EERC's mission to provide practical, pioneering solutions to the world's energy and environmental challenges. He represents the EERC regionally, nationally, and internationally in advancing its core research priorities: coal utilization and emissions, carbon management, oil and gas, alternative fuels and renewable energy, and energy–water.

2003–June 2015: Associate Director for Research. Mr. Harju led a team of scientists and engineers building industry–government–academic partnerships to carry out research, development, demonstration, and commercialization of energy and environmental technologies.

2002–2003: Senior Research Advisor. Mr. Harju developed, marketed, managed, and disseminated research programs focused on the environmental and health effects of power and natural resource production, contaminant cleanup, water management, and analytical techniques.

2017–Present: Adjunct Lecturer, Department of Petroleum Engineering, UND.

1999–2002: Vice President, Crystal Solutions, LLC, Laramie, WY. Mr. Harju's firm was involved in commercial E&P produced water management, regulatory permitting and compliance, and environmental impact monitoring and analysis.

1997–2002: Gas Research Institute (GRI) (now Gas Technology Institute [GTI]), Chicago, IL.
2000–2002: Principal Scientist, Produced Water Management. Mr. Harju developed and deployed produced water management technologies and methodologies for cost-effective and environmentally responsible management of oil and gas produced water.

1998–2000: Program Team Leader, Soil, Water, and Waste. Mr. Harju managed projects and programs related to the development of environmental technologies and informational products related to the North American oil and gas industry; formulated RFPs, reviewed proposals, and formulated contracts; performed technology transfer activities; and supervised staff and contractors. He served as Manager of the Environmentally Acceptable Endpoints project, a multiyear program focused on rigorous determination of appropriate cleanup levels for hydrocarbons and other energy-derived contaminants in soils. He led GRI/GTI involvement with industry environmental consortia and organizations, such as PERF, SPE, AGA, IPEC, and API.

1997–1998: Principal Technology Manager (1997–1998) and Associate Technology Manager (1997), Soil and Water Quality.

1988–1996: EERC, UND.
1994–1996: Senior Research Manager, Oil and Gas Group. Mr. Harju served as:
- Program Manager for assessment of the environmental transport and fate of oil- and gas-derived contaminants, focused on mercury and sweetening and dehydration processes.
- Project Manager for field demonstration of innovative produced water treatment technology using freeze crystallization and evaporation at oil and gas industry site.
- Program Manager for environmental transport and fate assessment of MEA and its degradation compounds at Canadian sour gas-processing site.
- Program Manager for demonstration of unique design for oil and gas surface impoundments.
- Director of the National Mine Land Reclamation Center for the Western Region.
- Co-PI on project exploring feasibility of underground coal gasification in southern Thailand.
- Consultant to an International Atomic Energy Agency program entitled "Solid Wastes and Disposal Methods Associated with Electricity Generation Fuel Chains."

1988–1994: Research Manager (1994), Hydrogeologist (1990–1994), Research Specialist (1989–1990), and Laboratory Technician (1988–1989).

Professional Memberships
National Coal Council (appointed 2018)
National Petroleum Council (appointed 2010)
Mainstream Investors, LLC, Board of Governors (2014–present)
DOE Unconventional Resources Technology Advisory Committee (2012–2014)
Interstate Oil and Gas Compact Commission (appointed 2010)
Rocky Mountain Association of Geologists

Publications and Presentations
Has authored or coauthored more than 100 professional publications and nearly 300 technical presentations.

JEFFREY SCHWARZ, PE

Project Manager

Jeff has served as Project Manager, Assistant Project Manager, and Engineering Manager for the technical development and execution of simple-cycle, combined-cycle, cogeneration, reciprocating engine, IGCC, and coal fired projects for Burns & McDonnell's Energy clients. Additionally, he has worked on natural gas storage projects and midstream fractionation plants for the Oil, Gas, and Chemicals Division. His duties include project management, engineering management, and project development. Jeff has extensive international experience having performed projects in Canada, South America, Central America, Europe, and Southeast Asia

EDUCATION

Bachelors, Mechanical Engineering, 1997

REGISTRATIONS

Professional Engineer (MO)

20 YEARS WITH BURNS & MCDONNELL

24 YEARS OF EXPERIENCE

Genesee Unit 1 and Unit 2 Repower | Capital Power Alberta Limited Partnership

Edmonton, Canada | 2021-Present

Project manager. Repower of Genesee Unit 1 and Unit 2 steam turbines with MPS 501 JAC Combustion Turbines and Vogt Triple Pressure HRSG's. Each train is capable of producing approximately 800 MW, for a combined facility output of 1600 MW. Project Manager for the detailed design of the Genesee Repowering Project located near Edmonton, Alberta, Canada. This project consists of two MPS M501 JAC gas turbines coupled with Vogt triple pressure HRSG's to repower Genesee's existing Unit 1 and Unit 2 steam turbines. As Project Manager for this detailed design project, Mr. Schwarz is responsible for oversight of engineering, project schedule, constructability reviews, project controls, and startup management coordination. Mr. Schwarz is responsible for ensuring the deliverables to the Owner are provided on-schedule and on-budget, while still meeting all of the quality and safety objectives of the project. Mr. Schwarz is the primary interface with the Owner for Burns & McDonnell.

NGL Fractionation Plant | ONEOK Hydrocarbon LP

Mont Belvieu, Texas | Oct 2017 - Mar 2021

Engineering manager. Conducted FEP-1 & FEP-3 studies, prepare a definitive cost estimate (±10%), and execute detailed engineering, procurement, and construction for a 125,000 barrel per day Natural Gas Liquids (NGL) Fractionation Plant. The plant's products include purity ethane, HD2 or HD5 propane, isobutane, normal butane and natural gasoline. Jeff worked on the expansion of Oneok's Mont Belvieu Facility in Mont Belvieu, Texas. Burns & McDonnell served as the EPC Contractor for the expansion of Oneok's Facility. The new Unit processes 75,000 BPD of raw Y-Grade Natural Gas Liquids (NGL) and separates the raw feed into recoverable products (ethane, propane, isobutane, normal butane, and natural gasoline). The recovered products from the NGL fractionation units are pumped from independent surge drums, using a series of booster and pipeline pumps through a metering skid for custody transfer. The final products are delivered to storage or directly to pipeline. Jeff is responsible for ensuring all engineering disciplines are meeting the project requirements in terms of quality, schedule, and budget.

JEFFREY SCHWARZ, PE
(continued)

Manlove Field Station Project | WE Energies
Illinois | Nov 2018 - Dec 2020

Engineering manager. People's Gas is replacing aging compressors with the installing new CAT3616 driven Ariel compressor and the upgrade to all major equipment and piping in the dehydration process (1100 SCFD). Burns & McDonnell scope includes managing design and procurement for the upgrade to the site-wide emergency shut-down system. This included specification, evaluation and negotiation of the major equipment supply contracts including the gas compressor, aftercooler, dehydration contactor/reboilers, slug catchers and inlet filters Jeff worked on the upgrade of a natural gas storage facility located near Fisher, Illinois. Burns & McDonnell served as the EPC Contractor for this phased project. Phase 1 consisted of the demolition of 4 natural gas compressors and replaced them with one larger new engine/compressor. This new gas compressor is used in the summer to compress pipeline gas and store it in the sandstone formations below the station. During the wintertime, stored natural gas is withdrawn from the formations and supplies approximately 40% of Chicago's natural gas. Phase 2 of the project consisted of demolishing much of the existing withdrawal equipment and replaced with new equipment to remove brine water from the natural gas and reduce the moisture content to that of pipeline quality natural gas. A new slug catcher, heaters, contactor towers, and reboilers were provided to serve this function, along with new gas pressure reduction stations. Phase 3 of the project consisted of an electrical upgrade for the entire facility. New auxiliary generators were supplied as well as replacement of existing MV Switchgear, LV Switchgear, and MCC's throughout the existing facility. Jeff was responsible for all engineering for this project. Additionally, Jeff oversaw all procurement for this project.

Schofield Generation Station | Hawaiian Electric Company, Inc.
Wahiawa, Hawaii | Jan 2016 - Jul 2020

Project manager. Jeff worked on a reciprocating engine project located in Oahu, Hawaii. Burns & McDonnell, in a Joint Venture with American Piping and Boiler, served as the EPC Contractor for this for this reciprocating engine facility consisting of a 6 Wärtsilä 20V34DF Engines to provide electricity to the grid and Schofield Army Barracks. As Project Manager, Jeff was responsible for oversight of engineering, procurement, project controls, and startup, as well as coordinating with our JV partner on construction issues. Jeff was responsible for ensuring the deliverables to the Owner and JV partner were provided on-schedule and on-budget, while still meeting all of the quality and safety objectives of the project. Jeff was the primary interface with the Owner for Burns & McDonnell.

SABIC Combined Heat & Power Feasibility Study and Cogeneration Project | Sabic Innovative Plastics Mt Vernon Llc
Indiana | May 2014 - Jan 2020

Project manager. Jeff worked on a cogeneration project located in Indiana. Burns & McDonnell, in a Joint Venture with Industrial Contractors Skanska Inc. is serving as the EPC Contractor for this for this cogeneration facility consisting of a single GE 7EA Gas Turbine and HRSG, and two Auxiliary Boilers designed to provide process steam and power for an existing industrial facility. As Project Manager, Mr. Schwarz is responsible for oversight of engineering, procurement, project controls, and startup, as well as coordinating with our JV partner on construction issues. Mr. Schwarz is responsible for ensuring the deliverables to the Owner and JV partner are provided on-schedule and on-budget, while still meeting all of the quality and safety objectives of the project. Mr. Schwarz is the primary interface with the Owner for Burns & McDonnell.

Warren County Power Station | Warren County Energy Partners
Front Royal, Virginia | Jun 2011 - Oct 2017

Engineering manager and project manager. Dominion's 3x1 combined cycle located in Virginia, an EPC project, included the addition of (3) G-class gas turbines, HRSGs, steam turbine and associated equipment. Jeff worked on the Warren County

JEFFREY SCHWARZ, PE
(continued)

Power Station located in Front Royal, Virginia. This project received Power Engineering Magazine's award in 2015 for Gas Fired Project of the Year and Overall Project of the Year. Burns & McDonnell, in a joint venture with Zachry Industrial Inc., is serving as the EPC Contractor for this for this 1,350 MW (nominal) 3x1 combined cycle utilizing Mitsubishi 501G gas turbines, Mitsubishi steam turbine, Alstom HRSGs, and SPX Air Cooled Condenser. Mr. Schwarz is responsible for ensuring all engineering disciplines are meeting the project requirements in terms of quality, schedule, and budget. Mr. Schwarz is also responsible for working with the Owner and JV construction partner to ensure satisfaction with the overall engineering design. As Project Manager, Mr. Schwarz is responsible for overseeing engineering, procurement, project controls, construction, and startup, as well as coordinating with our JV partner on construction issues. Mr. Schwarz is also responsible for interfacing with the Owner.

Shepard Energy Centre | Burns & McDonnell Canada Ltd.

Alberta, Canada | Apr 2009 - Mar 2016

Project manager. Jeff worked on the Shepard Energy Centre located in Calgary, Alberta, Canada. Burns & McDonnell is serving as the Owner's Engineer for this 800 MW (nominal) 2x1 combined cycle utilizing Mitsubishi 501G gas turbines, Mitsubishi steam turbine and Vogt HRSGs. As Project Manager, Mr. Schwarz was responsible for development of the EPC RFP, evaluation of the EPC Contractors' bids, and development/negotiation of the EPC contract with the selected EPC Contractor. During execution of the EPC contract, Mr. Schwarz was been responsible for ensuring the EPC Contractor is complying with the EPC contract. Additionally, Mr. Schwarz remained in constant contact with the Owner's team, the OE team, and EPC Contractor to ensure the goals of the project are being met.

Halton Hills Generating Station | Burns & McDonnell Canada Ltd.

Toronto, Canada | Sep 2006 - Sep 2014

Assistant project manager. Jeff worked on the Halton Hills Generating Station located near Toronto, Canada. Burns & McDonnell, in a joint venture with Aker Kvaerner Songer, was the EPC Contractor for this 700 MW (nominal) 2x1 combined cycle utilizing Siemens gas turbines, Alstom STG, Alstom HRSGs, and a SPX air cooled condenser. As Assistant Project Manager, Mr. Schwarz was responsible for establishing project strategy, contract negotiations, and oversight of engineering, procurement, schedule/cost control, and construction. Mr. Schwarz was also responsible for oversight of Hatch Energy, who performed the electrical and structural engineering on a subcontract basis.

Emery Generating Station | Alliant Energy Corporation

Iowa | Apr 2002 - Jul 2007

Development engineer. The Power Iowa project included two General Electric 7FA combustion turbine-generators (CT) coupled with two heat recovery steam generators (HRSG) and a single common steam turbine-generator (ST) to operate in combined cycle mode. 2x1 7FA duct fired combined cycle in Iowa including conceptual design, performance estimates, emissions estimates and capital cost estimate

IGCC Evaluation | Electric Power Research Institute

Texas | Mar 2006 - Dec 2006

Project team. EPRI, in conjunction with CPS Energy, hired Burns & McDonnell to evaluate the feasibility of installing an IGCC project in Texas, firing PRB fuel. Mr. Schwarz served as Project Manager for this effort and was responsible for evaluating capital cost, performance, O&M for IGCC technology in addition to PC technology. The results of this study were published by EPRI (EPRI Document # 1014510 entitled "Feasibility Study for an Integrated Gasification Combined Cycle at a Texas Site").

JEFFREY SCHWARZ, PE
(continued)

City Public Service | CPS Energy
San Antonio, Texas | Mar 2005 - Sep 2006

Performance test engineer. Jeff worked on 2x1 GE 7FA Combined Cycle Unit located in San Antonio, Texas. Included development of performance test procedure, performance testing, and generation of performance test report. Performance test was in general accordance with PTC 46.

El Paso Electric | El Paso Electric Company
Texas | May 2004 - Dec 2005

Development engineer. Evaluation of simple cycle and combined cycle power projects utilizing 7FA gas turbines. Mr. Schwarz performed several economic evaluations to help further define the optimal equipment selection for this project. These evaluations included duct firing vs. non-duct firing, wet vs. dry cooling and an inlet air cooling study that evaluated evaporative cooling, fogging, and chilling utilizing thermal storage (off-peak chilling). In addition, Mr. Schwarz provided capital cost estimates for many construction approaches, including simple cycle, combined cycle, and phased construction of simple cycle to combined cycle.

Solid Fuel-Fired Power Plant Feasibility Study | Wisconsin Public Service Corp.
Wisconsin | Jun 2004 - Dec 2005

Project team. Mr. Schwarz was responsible for providing a technology assessment evaluating 32 technologies including coal, natural gas, nuclear, and renewable energy. The technology assessment included a general discussion of each technology, capital cost, performance, emissions, O&M. Following this study, the selected technologies were evaluated further for multiple sites.

Colorado Springs Utilities | Colorado Springs Utilities
Colorado | Apr 2002 - Dec 2002

Development engineer. Evaluation of 21 different electrical generation options for an Electric Resource Supply Cost Study. These generation options ranged from 500 kW fuel cells to 500 MW coal fired generating station. Each generation option was evaluated on performance, capital cost, O&M, emissions, and availability estimates. Mr. Schwarz also provided very comprehensive site-specific estimates for a 250 MW and 500 MW PC Unit to be located at the Nixon site. Additionally, Mr. Schwarz was involved in development of a 150 MW CFB Project utilizing an advanced CFB boiler design from Foster Wheeler. Mr. Schwarz supplied CSU with a site-specific capital cost estimate, O&M estimate, heat balance, site layout, and project schedule to aid CSU in obtaining a grant from the Department of Energy for the Clean Coal Power Initiative.

Bonnet Carre Project | Sempra Generation, LLC
New Orleans, Louisiana | Nov 2001 - Dec 2002

Development engineer. Two blocks of 2x1 7FA Combined Cycle to be located in New Orleans, Louisiana. This effort included providing performance estimates for the project, as well as performing a heat rejection optimization that determined the optimum condenser and cooling tower sizing to maximize performance and minimize capital cost.

PATRICIA (TISHA) SCROGGIN-WICKER, PE

Director of Process Technology

Patricia is the Director of Process Technology for our power generation business working with Energy clients at Burns & McDonnell. Her team's responsibilities today include the Hydrogen, Carbon Capture, Liquified Natural Gas (LNG), Flow Battery and other process-oriented technology applications within the power generation industry.

Her career has included from the outset experiences with air quality control, chemical feed, water treatment and other process-oriented technologies. She's had experiences with numerous first of a kind installations including engineering, construction and startup experiences.

EDUCATION

Bachelors, Chemical Engineering, 2002

REGISTRATIONS

Professional Engineer (GA, IL, MO, NH)

19 YEARS WITH BURNS & MCDONNELL

19 YEARS OF EXPERIENCE

Hydrogen and Carbon Capture

Process Technology Director. Assist clients with identifying applicable technology that meets project needs from a scope, schedule and budget perspective. Provide direction to project teams as they are executing technology reviews, scale up evaluations, pilot projects and grid scale projects.

LNG Industry Lead

Multiple Locations | 2019 - Present

Business Manager. Responsible for market understanding, OEM relationships and technical applications around the peak shaving LNG market with respect to the power generation market.

Flow Battery Industry Lead

Multiple Locations | 2019 - Present

Business Manager. Responsible for market understanding, OEM relationships and technical applications for the evolving flow battery industry. Submitted on over 100 MWhr of flow battery project opportunities.

Water Redirection Program | Duke Energy Corp

Multiple Locations | Oct 2015 - Sep 2020

Process consultant. Worked on multiple process wastewater facilities at twelve stations. FGD wastewater treatment system includes clarification, filtration, biological and final polishing.

FGD Physical/Chemical & ZLD Wastewater Treatment | Indianapolis Power & Light Company

Petersburg, Indiana | May 2014 - Jul 2020

Process consultant. IP&L's waste-water treatment plant project, an EPC project, included the addition of a water treatment plant with a zero-discharge facility, thermal evaporation system, and a distillate stream for reuse in the FGD and other systems as permitted in order to discontinue the discharge of bottom ash, fly ash, FGD, and other waste-water materials into their existing ash ponds. The proposal includes as an option the installation of a bottom ash dewatering system allowing for the dewatered ash to be transported to a permitted landfill for disposal. Worked on multiple process wastewater facilities at a

PATRICIA (TISHA) SCROGGIN-WICKER, PE
(continued)

1,760-MW coal-fired facility. FGD wastewater treatment system includes clarification, softening and thermal evaporation using falling film evaporators. Remaining plant wastewater flows are treated within an enhanced heavy metals precipitation process followed by a mercury reduction filtration system.

High Desert Power Project | Tenaska, Inc.
Kansas City, Missouri | Mar 2015 - Feb 2017

Process engineer. Worked on optimization of existing Zero Liquid Discharge system on combined cycle cooling tower blowdown system. Coordination with existing plant operations while optimizing various systems.

Mustang | OGE Energy Corp.
Oklahoma City, Oklahoma | May 2014 - Sep 2016

Process engineer. Worked on FEED study to develop new generation simple cycle and combined cycle site. System design including raw water treatment, demineralization, sampling and cooling tower and cycle chemical feed systems.

Confidential Client | Big Rivers Electric Corporation
Henderson, Kentucky | Jul 2013 - Dec 2014

Project team. Multiple facility review of existing plant water balances for identification and implementation of water reuse and wastewater minimization technologies. Determine potential compliance requirements associated with upcoming proposed National Effluent Limitation Guidelines.

Frank A. Tracy Generating Station | NV Energy, Inc.
Nevada | Feb 2012 - Dec 2013

Process engineer. Worked to review the plant water usage and treatment capabilities to develop a comprehensive water management plan. The plan improved water usage and optimize the use of water treatment equipment to maintain zero liquid discharge operation. This facility is a multi-unit station with oil and gas fired units.

Iatan 2 | Evergy, Inc.
Kansas City, Missouri | Dec 2005 - Jul 2013

Process engineer. Worked on design, procurement and 2.5-year assignment onsite for construction oversight and startup of water related systems at a new 900-MW coal-fired power plant. Systems include wastewater treatment system, condensate polishing, raw water treatment, boiler cycle, sampling and demineralized water. New unit, including scrubber blowdown, is a Zero Liquid Discharge (ZLD) site.

Merrimack Station - Zero Liquid Discharge | Eversource Energy
New Hampshire | Oct 2010 - Apr 2013

Process engineer and Project Manager. Worked on fast track technology selection, design, procurement, and startup of an evaporator/crystallizer Zero Liquid Discharge system for FGD wastewater. System has ability to produce a concentrated stream for landfilling with fly ash, or a fully dry waste product suitable for landfill.

PATRICIA (TISHA) SCROGGIN-WICKER, PE
(continued)

Council Bluffs Unit 3 | MidAmerican Energy
Iowa | Nov 2006 - Dec 2011

Process engineer. MidAmerican Energy's Council Bluffs Unit 3 AQCS project, an EPC project, included the addition of two SDAs, two fabric filters, ID fans and related equipment for the 700 MW unit. Worked on air pollution control upgrade at 690-MW coal-fired power plant. Duties included design review, drawing review, equipment checkout, water balance design and interfacing with other disciplines and contracts. Equipment included dry scrubbers, fabric filters, ductwork, lime slakers and recycle slurry ash systems.

Louisa Scrubber Project | MidAmerican Energy
Iowa | Nov 2005 - Dec 2011

Contract engineer. Worked on air pollution control upgrade at 700-MW coal-fired power plant. Duties included design review, drawing review, equipment checkout, water balance design and interfacing with other disciplines and contracts. Equipment included dry scrubbers, fabric filters, ductwork, lime slakers and recycle slurry ash systems.

Termoelectrica de Mexicali | Termoelectrica De Mexicali S De RL De CV
| Oct 2003 - Dec 2007

Process engineer. Worked on design, specification, procurement and submittal reviews for water system equipment upgrades at 500-MW combined cycle power plant. Wrote equipment procurement contracts, performed bid evaluations and reviewed drawing submittals for additional lime slaker, silo, and redundant pressure filter and demineralizer system.

Emery Generating Station | Alliant Energy
| Apr 2002 - Jul 2007

Process engineer. The Power Iowa project included two General Electric 7FA combustion turbine-generators (CT) coupled with two heat recovery steam generators (HRSG) and a single common steam turbine-generator (ST) to operate in combined cycle mode. Worked on design, procurement, and construction of water related systems at 550-MW combined cycle power plant. Systems include cycle chemical feed, circulating water chemical feed, raw water chemical feed, demineralized water, potable water, sampling and analysis, service water, raw water, and well water. Design involved use of reclaimed water and well water for primary cooling water makeup needs. Preparation of fully comprehensive life cycle cost analysis and plant water balance.

Sheboygan Falls Energy Station | Alliant Energy
| Jan 2004 - Sep 2006

Process engineer. Worked on design, procurement, and construction of water related systems at 350-MW simple cycle power plant. Wrote equipment procurement contracts, performed bid evaluations and reviewed drawing submittals for both the service water chemical feed and potable water systems.

Meramec, Rush Island & Sioux Power Plants | Ameren Corporation
| Mar 2003 - Mar 2004

Process engineer. Worked on primary water treatment and potable water system studies. Studies included existing equipment assessment, design basis review in terms of performance, functionality, reliability, and redundancy, identification of required equipment replacements and significant maintenance expected during the next 10 years, assess current and future compliance with EPA and MO-DNR drinking water regulations, propose modifications and upgrades to existing systems,

PATRICIA (TISHA) SCROGGIN-WICKER, PE

(continued)

evaluate alternatives for potable water supply. Preparation of anticipated capital expenditures and operating and maintenance expenses to keep system operating. Life cycle cost analysis for alternative water treatment options.

Timothy E Thomas

Senior Vice President & Deputy General Manager
Engineered Systems Division
Mitsubishi Heavy Industries America

Overview

Mr. Thomas is currently Senior Vice President & Deputy General Manager for the Engineered Systems Division of Mitsubishi Heavy Industries America (MHIA) in Houston, TX and oversees MHIA's CO_2 capture business for North America. He is responsible for safety, business development, project development and implementation from initial concepts, feasibility studies, and FEED studies through project completion. Mr. Thomas has over 38 years of related experience including CO_2 capture systems (CCS), flue gas desulfurization (FGD) systems, material handling systems, wastewater treatment systems, and particulate removal systems.

Project Specific Experience

Directs and oversees the preparation of multiple detailed studies for the application of MHIA's CCS including FEED studies for Prairie State and San Juan power plants. Primary focus on the application and feasibility of installing CCS on power and industrial flue gas sources.

· Project Director from 2002 to 2013 for the design, procurement, construction, and commissioning of FGD systems at multiple TVA fossil fuel power plants. These installations completed on schedule and within budget and valued at over $1 billion were provided to TVA through Advatech, a joint venture of URS and MHIA.

· Project Engineering Manager during the $340 million FGD system retrofit for Pennsylvania Electric's Conemaugh Station Units 1 and 2. Managed development of systems design; design criteria; process and instrumentation diagrams; design calculations and equipment optimization; operating procedures and system descriptions.

· On-site Resident Engineer for the construction of JEA/FPL's St. Johns River Power Park, two 600 MW coal-fired generating units. Oversaw the installation of the FGD systems, electrostatic precipitators, and a wastewater treatment facility.

Specialized Training

BS / 1983 / Mechanical Engineering / University of Florida

Chronology

Mitsubishi Industries America, Inc. – Senior Vice President, Vice President, Deputy General Manager, Engineered Systems Division, 2013 to present
URS Corp. and Advatech LLC, Vice President, Project Director, Project Manager, 1996 – 2013
URS - Raytheon Engineers and Constructors – Ebasco Services, Project Engineering Manager, Principal Mechanical Engineer, Senior Mechanical Engineer, Mechanical Engineer, Sr. Associate Engineer, 1983 - 1996

Professional Summary

Name : **Shingo Watanabe**

Position in this Project : **Project Manager**

He will be responsible for:

- Overall Project Control such as
  - Cost control
  - Project schedule control
  - Project risk control
  - Resource control
  - Change order control
- Project Estimation

Criteria for Qualification

- Project Management Professional (PMP) in 2017
- Fundamentals of Engineering ("FE") in 2000
- Project Management Specialist (PMS), P2M based Project Management Professionals Certification by Project Management Association of Japan in 2003

Summary of Experience

Twenty-seven (27) years experiences with Mitsubishi Heavy Industries Group, served as Piping Engineer and Project Management for chemical plant.

Languages

Japanese	:	Native
English	:	Business-level

Professional Summary

Education

Education	:	Yokohama National University
Qualification	:	Master of Mechanical Engineering
Joined MHI	:	April 1, 1994

Personal Data

Nationality	:	Japanese
Date of Birth	:	October 3, 1969

Position in MHI's Organization **: Project Manager,**

Mr. Watanabe's Significant Experience

Project Manager (GCGV)

- Polyethylene
  650,000T/Y x 2

  2018 - present
  Capacity : 650,000 T/Y × 2 (PE)
  450,000 T/Y (PP)

TX USA

for Gulf Coast Growth Ventures LLC

Basic design, detail design, procurement and construction.

Group Manager, Plant Layout & Piping Engineering Group

- Responsible for all Plant Layout & Piping Engineering Activities, including authorization of documents, cost estimation for bidding projects, personnel's mobilization, etc.

  2013 - 2016

Management in MCEC

Lead Piping Engineer(SAMUR)

- Fertilizer Complex
  - Ammonia
  - Urea and Granulation

  2011 - 2013

  Capacity : Ammonia: 2,100T/D
  Urea (Synthesis): 3,500T/D
  Granulation Urea: 3,850T/D
  & Urea Export Jetty

Sipitang, Sabah, Malaysia

for PETRONAS Chemical Fertilizer Sabah Sdn. Bhd. (PCFSSB)

Lump Sum Turn Key Basis, including Engineering, Procurement and Construction Works.
MHI, as leader of the consortium, is responsible for the basic and detailed design work, the procurement of equipment and the dispatch of technical advisors for installation and test operation.
APEX Energy and PT Rekayasa Industri (REKIND) take charge of a portion of the equipment procurement and construction work.

Professional Summary

Lead Piping Engineer(SPOX)

- Polyethylene (LDPE)
  (LLDPE / Metallocene LLDPE): Poly & Fin
  Polypropylene (PP)
  (Homo Polymer): Fin only

  2007 - 2011

  Jurong Island, Singapore

  for ExxonMobil Chemical Company

  Capacity : 650,000 T/Y × 2 (PE)
  450,000 T/Y (PP)

  Detailed Engineering, Procurement, Civil Works and Construction Works

Piping Engineer(OSF)

- Fertilizer Complex
  - Ammonia
  - Urea

  2005 - 2007

  Sohar Industrial Area, Oman

  for Sohar International Urea & Chemical Industries S.A.O.C. (SIUCI)

  Capacity : 2,000 T/D (Ammonia Plant)
  3,500 T/D (Urea Plants)

  Lump Sum Turn Key Basis, including Engineering, Procurement, Civil Works and Construction Works.

Assistant Engineering Manager (SMAG-2)

- Methyl Methacrylate (MMA) & SCO-2 Plant (Utility)

  2003 - 2005

  Sakura, Singapore

  for Sumitomo Chemical Co., Ltd.

  Capacity : 75,000 T/Y

  Lump Sum Turn Key Basis, including Basic / Detailed Engineering, Procurement, Construction and Commissioning

Assistant Piping Engineer (Kaltim-4)

- Fertilizer Complex
  - Ammonia

  Bontang, Kalimantan, Indonesia

- Urea

1999 – 2003

For P.T. Pupuk Kalimantan Timur

Capacity : 1,000 T/D
1,725 T/D

Lump Sum Turn Key Basis, including Engineering, Procurement, Civil Works and Construction Works.

Assistant Piping Engineer (NRT-II/Phase-II)

- LNG Receiving Terminal (Expansion/Phase-II)
  Capacity:4,000,000 T/Y

1998 – 1999

Niigata, Japan

for Nihonkai LNG Company Ltd.

Lump Sum Turn Key Basis, including following facilities:
- LNG Tanks (100,000 Kl x 2)
- LNG Vaporizer / LNG Pumps
- LNG Piping / others

Assistant Piping Engineer (PFK)

- Fertilizer Complex
  - Ammonia
  - Urea (Granulated)
  - Methanol
  - Urea Formaldehyde

1996 - 1997

Gurun & Butterworth, Malaysia

for Petronas Fertilizer (Kedah) Sdn. Bhd.

Capacity : - 1,125 T/D (Ammonia Plant)
- 1,800 T/D (Urea Plant, Granulated)
- 200 T/D (Methanol Plant)
- 17 T/D (Urea Formaldehyde)

Grass-Roots Lump Sum Turn Key Basis
Facilities consisting of Fertilizer Plant, Urea Export Terminal and Railway

Assistant Piping Engineer (NRT-II/Phase-I)

- LNG Receiving Terminal (Expansion)

1995 - 1996

Niigata, Japan

for Nihonkai LNG Company

Ltd.

Capacity : 4,000,000 T/Y

Lump Sum Turn Key Basis, including Basic / Detailed Engineering, Procurement, Construction and Commissioning

Lump Sum Turn Key Basis, including following facilities:
- LNG Tanks (100,000 kL x 2)
- LNG Vaporizer / LNG Pumps
- LNG Piping / others

Professional Summary

Name : **Atsushi Yoshitomi**

Position in this Project : **Engineering Manager in this Project**

The Engineering Manager will be responsible for :

- Coordinate with Owner's engineers etc.
- Manage discipline lead engineers
- Maintain Engineering data base

Criteria for Qualification

- Four (4) year experience of Project Engineer
- Eleven (11) year experience of Civil, Structural & Architectural Engineering on several Chemical Plants

Summary of Experience

Eleven (11) years experience with Mitsubishi Heavy Industries Group, served as Civil, Structural & Architectural Engineer on several Chemical Plants and Four (4) years experience with Mitsubishi Heavy Industries Group, served as Project Engineer on a Chemical Plant.

Languages

Japanese	:	Native
English	:	Business-level

Education

Education	:	Osaka University
Qualification	:	Master of Civil Engineering
Joined MHI	:	April 1, 2006

Professional Summary

Personal Data

Nationality : Japanese

Position in MHI's Organization **: Project Department**

Mr. Yoshitomi's Significant Experience

Project Engineer (GCGV)

- Polyethylene (LDPE) — Copus Christi, Texas, USA

  2018 - present — for Gulf Coast Growth Ventures

  Capacity : Polyethylene Polymerization : 650,000 ton/year x 2 trains
  Polyethylene Finishing: 650,000 ton/year x 2 trains

  Lump Sum Mechanical Completion, Scope of Work is Basic Design, Detail Design, Procurement and Construction. (Consortium formation: Engineering and Procurement by MHI-A, Construction by the consortium partner Zachry)

Civil & Structural Engineer (NAG)

- Polyethylene (LDPE) — Mont Belvieu, Texas, USA

  2013 - 2017 — for ExxonMobil Chemical Company

  Capacity : Polyethylene Polymerization : 650,000 ton/year x 2 trains
  Polyethylene Finishing, Packaging, and Shipping: 650,000 ton/year x 2 trains

  Lump Sum Turn Key Basis, including Engineering, Procurement and Construction Works. (Consortium formation: Engineering and Procurement by MHI-A, Civil and Construction by the consortium partner PCI and ISC)

Civil & Structural Engineer (NAG-FEED)

- Polyethylene — USA

  2011 - 2013 — for A Company

  Capacity : N.A.

  FEED (Front End Engineering Design)

HVAC Engineer (TAF)

- Fertilizer Complex
  - Ammonia
  - Urea
  - Methanol
  - Utility & Offsite

Mendeleev city , Tatarstan Republic, Russia

for Ammoni (Joint Stock Company Ammoni)

2011 – 2012

Capacity : 2,050 T/D (Ammonia)
2,050 T/D (Urea)
668 T/D (Methanol)

Lump Sum Turn Key Basis collaborating with China National Chemical Engineering Corporation, CNCEC (China)

MHI's Scope of Work: Engineering, Off-shore Procurement and Supervision

Civil & Structural Engineer (SPOX)

- Polyethylene (LDPE)
  (LLDPE / Metallocene LLDPE): Poly & Fin
  Polypropylene (PP)
  (Homo Polymer): Fin only

Jurong Island, Singapore

for ExxonMobil Chemical Company

2008 - 2011

Capacity : 650,000 T/Y × 2 (PE)
450,000 T/Y (PP)

Detailed Engineering, Procurement, Civil Works and Construction Works

Assistant Civil & Structural Engineer (METOR-EXPANSION Project)

- Methanol Plant (Expansion)

Jose, Venezuela

2007 – 2008

for Methanol De Oriento, METOR, S.A.

Capacity : 2,500 T/D

Lump Sum Turn Key Basis, consortium with INELECTRA

Professional Summary

Assistant Civil & Structural Superintendent (AR-RAZI-V Plant Project)

- Methanol Plant — Al-Jubail, Saudi Arabia

  2007 — for Saudi Methanol Company (AR-RAZI)

  Capacity : 5,000 T/D

  Lump Sum Turn Key Basis, including Basic / Detailed Engineering, Procurement, Construction and Commissioning Supervision

Assistant Civil & Structural Engineer

- Various Chemical Plants

  2006 - 2007

  Capacity : NA

John Bauer

jbauer@grenergy.com, Office (701) 442-7000, Cell (701) 897-1853

Summary

As Director of North Dakota Generation for Great River Energy I have oversight of Great River Energy's Coal Creek Station. With over 40 years of experience in the industry, I possess a wealth of power and process knowledge and strive to enhance culture, teamwork, and leadership to maintain a highly engaged work force.

The honor to serve as a member of the Bismarck State College foundation board and as chair of Electric Power Research Institute's operations management technology program provides an opportunity to offer input that creates a well-trained workforce ensuring we improve operations and achieve safe, reliable, cost-effective and environmentally responsible power generation.

This first-hand knowledge and experience allow me to effectively contribute to the overall success of GRE's ND operation regardless of the situation.

EXPERIENCE:

Director, North Dakota Generation
March 2017 – current
Lead, plan and direct the operation and maintenance of North Dakota generating facilities in accordance with Great River Energy's (GRE) values, mission, and strategic imperatives, to achieve safe, reliable, efficient and environmentally sound production of electricity.

Manager, ND Operations Services
April 2015 – March 2017
Provide management oversight for plant operations, fuel operations and utility groups at Great River Energy's Coal Creek, Stanton and Spiritwood facilities. Provide overall site management for Spiritwood Station. Current Alternate Designated Responsible person for ND environmental compliance.

Leader, Plant Operations (day coordination) Great River Energy, Coal Creek Station
Oct 2005 – April 2015
Act as the Operating Authority and provide daily coordination for Coal Creek Station Plant Operations, Facilitate hiring and training for new hires (Operators / Operator Technicians), Mentor the 60 member Operations Team, coordinate new projects affecting the station, system start-up commissioning, work around guidance and emergent response to limit generation loss, Incident Commander for HazMat, fire and unit incidents, Provide leadership to the Operator Technician, Building Maintenance Utility and Temp Labor groups.

Leader, Plant Operations (shift coordination) Great River Energy, Coal Creek Station
Sept 2001 – Sept 2005
Act as the Operating Authority of Coal Creek Station, coordinate shift operation of a 12 member self-directed work team at Coal Creek Station, provide maintenance guidance on short outage and emergent situations to limit generation losses.

Control Room Operator Great River Energy, Coal Creek Station
July 1994 – Aug 2001
Operate Coal Creek Station from the central control room, coordinate maintenance efforts to support maintenance teams with clearances and equipment outage scheduling.

John Bauer

jbauer@grenergy.com, Office (701) 442-7000, Cell (701) 897-1853

Train other levels of plant operations to ensure qualified members for advancing positions.

Additional operations positions, Great River Energy, Coal Creek Station
Mar 1981 – June 1994
Monitor equipment, provide clearances, perform minor maintenance and provide troubleshooting support for Assistant Control Operator, Auxiliary Operator and Equipment Operator plant systems at Coal Creek Station. Provide job leader support for unit outages.

EDUCATION:

Great River Energy Leadership Training, Great River Energy
Foundational Leadership and Leadership in Action
MARC – Managers Guide to Employee Relations Leadership Training

Bismarck State College, Bismarck ND
Power Plant Technology

LEADERSHIP IN OTHER ORGANIZATIONS:

Bismarck State College Foundation board member

Program Chair for Electric Power Research Institute Plant Management Essentials Program

President, Ridgefield Condominium Association, Bismarck

SKILLS AND ABILITIES

Leadership Operations
Project Coordination
Mentoring
Safety
Expertise
Project Commissioning
Teamwork

Ethan Vaagene

evaagene@grenergy.com, Office (701) 442-7066, Cell (701) 460-7390

Summary

As Principal Engineer at Great River Energy's Coal Creek Station I am responsible for the technical research and analysis for the major plant electrical and protective systems. I have been responsible for large and complex projects at the plant in order to improve reliability and maximize efficiency. My experience has allowed me to obtain a vast knowledge of electrical and power plant knowledge.

I actively participate in outside organizations and committees with direct impact to the power industry. I have taken advanced courses to further my education and have expanded on this education to instruct college students at Bismarck State College.

My knowledge and expertise allow me to contribute to the overall success of Coal Creek Station and provide value to the industry outside of Great River Energy.

EXPERIENCE:

Principal Engineer, Coal Creek Station
January 2020 – current
Subject matter expert on electrical systems, electrical distribution, electrical apparatus, and relaying. Manage complex technical projects with critical financial and technical significance to Great River Energy. Present proposals and technical information to plant staff, leadership and corporate leadership with the responsibility to make timely, effective decisions with direct impact to Great River Energy.

Maintenance Supervisor, Coal Creek Station
February 2013 – January 2020
Responsible for the budget, management, and direct supervision of mechanics and E&I personnel at Coal Creek Station. Analyze data and reports to recommend and implement plant improvements. Develop procedures, standards and goals, in addition to preparing reports, that align with the vision of the company and regulatory directives.

Senior Systems Engineer, Coal Creek Station
November 2005 – February 2013
Responsible for the design, specifications, schedule, budget and project management of projects at Coal Creek Station. Manage and direct contractors and plant personnel for medium and large size projects. Provide daily plant support for operations and maintenance and conduct analysis, reports, and recommendations to plant staff and leadership.

EDUCATION:

University of North Dakota, Grand Forks ND
Bachelor of Science Electrical Engineering
Minor Mathematics

University of Mary, Bismarck ND
Master Business Administration w/Energy Management Focus

Ethan Vaagene

evaagene@grenergy.com, Office (701) 442-7066, Cell (701) 460-7390

CERTIFICATIONS and LEADERSHIP IN OTHER ORGANIZATIONS:

Engineer in Training Certification
Professional Engineer (PE-6878)
Professional Project Manager Certification
Member of IEEE
Member of DOBLE
Member of Society of Engineers
Adjunct Instructor for Bismarck State College I&C Department

SKILLS AND ABILITIES

Leadership
Project Management
Electrical Testing and Analysis
NEC, IEEE, ANSI, ASME Standards
Primavera, Maximo, Microsoft Office
Employee Development
NERC Compliance
Communication

Stacy L. Tschider

Stacy has strategically built and ran a successful business empire worth half a billion in revenues across the United States, Canada and Mexico. His portfolio of companies in the North American markets have over a quarter century of prominent success leading the wholesale electricity and natural gas, retail natural gas, propane, oil, and real estate industries.

His leadership and business savviness places him at the forefront in all companies he leads as President at: *Rainbow Energy Marketing Corporation, Peak Energy, Rainbow Energy Ventures, Rainbow Energy Center, and Nexus Line.* Entrepreneurial expertise in directing all aspects of operations and development in the highly complex and volatile energy trading commodities specializing in physical and financial products (spot prices, forwards, futures, options and derivatives), demonstrates his professional aptitude for risk management and profit generating strategies.

Stacy a founder of Rainbow Energy Center and Nexus Line, the newest additions to the REMC group of companies. Making strong progress toward diversifying vertically with ownership in two investments: a 1,151 MW power plant and 436 mile high voltage direct current (HVDC) transmission line in the upper Midwest. These acquisitions will not only pave the way in leading edge carbon capture and storage technology, more importantly save over 600 jobs with an estimated impact of $1.5 billion in local North Dakota communities. These recent developments are near and dear to his heart, as forging progress in his local community bring a heightened level of purpose in his entrepreneurial journey.

Jeff Jonson

Jeff has been pivotal in overseeing organizational efforts in business development, joint venture and acquisitions for a business empire worth half a billion in revenues across the United States, Canada and Mexico. His portfolio of companies in the North American markets have over a quarter century of prominent success leading the wholesale electricity and natural gas, retail natural gas, propane, oil, and real estate industries. He pioneered key international business development initiatives as Chief Executive Officer at *RC Energy*, as well as Executive Vice President at: *Rainbow Energy Marketing Corporation, Rainbow Energy Ventures, Rainbow Energy Center, and Nexus Line*.

With his executive leadership expertise in energy trading and asset management across North America, Jeff spearheaded market penetration of the newly formed Mexico energy markets, as Chief Executive Officer of RC Energy in Mexico. RC is a wholesale and retail energy joint venture positioned as one of the leading power, natural gas traders and asset managers in Mexico. Optimizing his expertise, he expanded his geographical footprint with clients in the Guatemalan power market, trading between Mexico and Guatemala.

His business acumen and leadership experience in the energy sector have been crucial in our progress towards acquisitions in the Coal Creek power plant and HVDC transmission line.

Chris Faul

Chris began working with Rainbow Gas, a regional natural gas marketer, and commercial and industrial supplier. He later joined the Rainbow Energy Marketing Corporation (REMC) in hourly trading and settlements, prior to his promotion to Manager of Energy Markets and Projects for REMC and Rainbow Energy Ventures (REV). He leads the REMC settlements team's vast portfolio of bilateral sales, ISO/RTO markets, and asset management deals. His profitable growth strategies have been proven with his project management skills in leading all REV virtual business agreements throughout North America, including a European client. Chris has been a valuable and trusted executive advisor since the inception of the REMC group of companies, and an important foundation to a fast-growing group of companies.

As Vice President of Operations for both Rainbow Energy Center and Nexus Line, Chris provides overall direction to major business division heads. His direct reports include Rainbow Energy Center power plant and IT division heads.

Ryan Davis

Following a 20-year career of trading physical and paper commodity markets, Ryan joined Rainbow Energy Marketing as Energy Director. He has leveraged experience in open outcry and electronic markets, along with managing a physical natural gas and power desk for a regional cooperative, to grow a natural gas and power portfolio for Rainbow Energy Marketing. In addition to marketing natural gas and power, current responsibilities include executing value added solutions mitigating risk for commodity producers and consumers, business development, contract negotiation and maintaining relationships with a network of market participants.

Lyndsey Roemmich

Lyndsey is a Certified Public Accountant with 17 years of experience in a variety of fields including 11 years in the utility industry. Lyndsey joined Rainbow Energy Marketing Corporation in 2018 and has specialized in accounting for monthly electricity transactions, established foreign accounting processes, and played a leading role in coordinating tax compliance and external audit requests. Lyndsey has managed various research and accounting projects as well as implemented numerous process improvements. Prior to her career at Rainbow Energy, Lyndsey worked at a local investor-owned utility. She played an integral role in financial statement preparation and analysis as well as regulatory reporting. Lyndsey also serves on various boards in the community and in the accounting industry.

As Vice President of Finance for both Rainbow Energy Center and Nexus Line, Lyndsey directs all aspects of accounting operations including analyzing financial results, assisting in financial planning and results management, and maintains all necessary accounting policies and systems to ensure that all records are maintained in accordance with generally accepted accounting principles.

BOB SLETTEHAUGH, P.E.

MANAGER OF CARBON CAPTURE

EDUCATION

M.S., Mechanical Engineering, Power, North Dakota State University, 1996

B.S. Mechanical Engineering Power, North Dakota State University, 1993

YEARS OF EXPERIENCE

Total Years in Industry: 27

Year Started at Company: 2019

LICENSES/REGISTRATIONS

Professional Engineer – KS

MEMBERSHIPS

American Society of Mechanical Engineers

PROFESSIONAL EXPERIENCE

Bob joined Kiewit as the Manager of Carbon Capture. His role includes increasing awareness of Kiewit as the market leader in Carbon Capture, developing relationships with technology providers, and winning projects. Kiewit is actively performing and pursuing projects in power (coal, natural gas), oil/gas/chemical (hydrogen, gas processing), industrial (cement, steel, ethanol, ammonia), as well as direct air capture. Carbon capture activities ranging from technology evaluations through front end engineering design (FEED); project development activities, including feasibility studies and technology assessments.

CAREER SUMMARY		
ROLE	**LOCATION**	**YEARS**
Sponsor	CA, CO, ND	2020-Present
Project Manager	US	1994-2019
Co-op Engineer	TN	1989-1991

SELECT KIEWIT & SUBSIDIARIES PROJECT EXPERIENCE

Sponsor, DOE/NETL and Climeworks, Direct Air Capture Using Novel Structured Adsorbents Pilot, CA (2020-Present)

Supporting Climeworks under the US Department of Energy (DOE) National Energy Technology Laboratory (NETL) agreement FE0031959, The overall goals of the project are to construct and operate a 30-kilogram-per-day (kg/day) integrated field test unit capable of producing a concentrated CO2 stream of at least 95% purity. Kiewit is performing detailed design, procurement, and construction of the facility.

Sponsor, DOE/NETL and Electricore, LH CO2MENT Colorado Project Pre-FEED, CO (2020-Present)

Supporting Electricore and Svante under DOE NETL agreement FE0031942. The objective is to scale up the Svante VeloxoTherm™ carbon capture plant at an existing cement plant to capture over 1 million tonne/yr. The project objectives include completing a pre-front-end engineering design (pre-FEED) for installation of the capture system at a LafargeHolcim-owned cement plant in Florence, Colorado. Kiewit is performing detailed design and overall capital cost estimate of the facility.

BOB SLETTEHAUGH, P.E.

MANAGER OF CARBON CAPTURE

Sponsor, DOE/NETL and Chevron, Chevron Natural Gas Carbon Capture Technology Testing Project Field Test, CA (2020-Present)

Supporting Chevron and Svante under DOE NETL agreement FE0031944. Field test of Svante VeloxoTherm™ solid sorbent carbon capture technology under indicative natural gas flue gas conditions and continuous long-term steady-state operation at Chevron's Kern River facility. The project is designed to capture approximately 30 tonne/day of CO2. Kiewit is performing detailed design, procurement, and construction of the facility.

Advisor, DOE/NETL and Prairie State, Carbon Capture Project FEED Study (2019-2021)

Supporting University of Illinois and Prairie State Generating under DOE NETL agreement FE0031841. Front-end engineering design (FEED) study for the retrofit of Unit 2 (approximately 816 MW) of Prairie State Generation Company's (PSGC) coal-fired power station in Marissa, Illinois, with an 8.4 MTPA post-combustion carbon dioxide (CO2) capture plant based on Mitsubishi Heavy Industries' (MHI) advanced KM CDR process. Kiewit is providing OSBL engineering and overall project cost estimate.

Sponsor, Midwest AgEnergy, Blue Flint Ethanol Carbon Capture, ND (2020)

Completed a Pre-FEED on existing ethanol plant to capture and compress approximately 180,000 tonne/yr as part of Midwest AgEnergy's CarbonZero initiative. Scope included process design, equipment selection, site layout, heat and material balances, as well as capital cost estimate and project schedule.

SELECT PRIOR PROJECT EXPERIENCE

Project Manager, KeyLogic/National Energy Technology Laboratory (NETL), Bituminous Baseline (2017-2019)

Reviewed the 2015 edition of the Cost and Performance Baseline for Fossil Energy Plants Volume 1a: Bituminous Coal and Natural Gas to Electricity, commonly referred to as the "Bituminous Baseline" report. Provided recommendations for updates to the size and design basis. Based on these recommendations, updated capital and O&M costs to support life cycle cost calculations were developed. The updated volume is expected to be released by NETL in 2019. The objective of this report is to establish a cost and performance baseline for fossil energy power systems with and without carbon capture. Other carbon capture technologies are then evaluated against this baseline.

Project Manager, Gas Technology Institute; Conceptual Design of Biomass to Natural Gas Plant; California, United States (2017-2018)

Developed a conceptual design to convert an existing biomass power plant into a biomass to renewable natural gas project. Deliverables included site specific layout, capital cost estimate, and performance estimates based on a woody biomass feedstock. https://www.gti.energy/wp-content/uploads/2019/02/Low-Carbon-Renewable-Natural-Gas-RNG-from-Wood-Wastes-Final-Report-Feb2019.pdf

BOB SLETTEHAUGH, P.E.

MANAGER OF CARBON CAPTURE

Project Manager, Leucadia Energy, LLC, Lake Charles Carbon Capture and Sequestration, Phase 1, United States (2009-2010)

Supported Leucadia under the US Department of Energy (DOE) National Energy Technology Laboratory (NETL) program “Carbon Capture and Sequestration from Industrial Sources and Innovative Concepts for Beneficial CO2 Use.” Services included supporting the Phase 2 funding application for the engineering, procurement, and construction (EPC) phase of project development.

Project Manager, RTI International, Dry Sorbent CO2 Capture Technical Evaluation, United States (2009-2010)

An independent technology evaluation and engineering analysis of RTI’s dry sorbent process for post-combustion CO2 capture to existing power plants. Preliminary selection and sizing criteria for process equipment were developed. The criteria were applied to develop a capital cost estimate, order of magnitude operations and maintenance cost estimate and power plant performance estimate. Developed a comparison with conventional amine technology for a nominal 600 MW pulverized coal unit.

Project Manager, Entergy, Due Diligence Review of the Powerspan Chilled Ammonia Process, Global, (2009)

An independent review of the Powerspan ECO2 technology, which captures CO2 using an ammonia-based solvent. The objectives of this study were to help the client understand the strengths and weaknesses of the ECO2 technology and its feasibility and commercial viability; and to develop a full-scale assessment for the existing Nelson Station Unit 6 pulverized coal fired boiler. Dr. Howard Herzog of MIT participated in the assessment.

Project Manager, Confidential Client, Due Diligence Review of the Catalytic Gasification Process, Global, (2009)

An engineering audit of a hydromethanation technology for catalytically converting solid fuels to SNG. The audit included a review of the fundamental thermodynamic, chemical, and physical processes; history and commercial status of the technology; capital and operating costs; scalability; and performance.

Project Manager, Aera Energy, LLC; Oxy-Combustion Technology Review; Global, (2009)

Provided the client with an independent, third-party opinion on whether a novel oxy-combustion technology can be economically utilized to provide power and CO2. Perform a technical, economic, siting, permitting, and commercial assessment of the Clean Energy Systems (CES) oxygen-fired gas generator technology for the production of power and CO2.

Project Manager, Confidential Client, Unconventional Oil Recovery, Global, (2008)

Assisted major oil company in developing design and cost estimates for a potential unconventional oil recovery technology utilizing molten salt-based heat exchanger technology. Evaluation included salt properties, materials of construction, heat and power requirement, as well as comparison against similar oil-based system.

Project Manager, Cansolv; CO2 Capture from Combined Cycle; Norway, (2007)

Supported the technology provider in a pre-FEED study to capture and compress at least 85 percent of the CO2 from the flue gas of a natural gas fired combined cycle. The scope included integration of the Cansolv amine-

based post-combustion capture technology into the overall system, CO2 compression, and overall capital cost and schedule estimates.

PREVIOUS WORK EXPERIENCE

Black & Veatch, Kansas; 1994 – 2019. Served in roles including as a Project Manager and leading various groups including: Technology Assessments, Technical Due Diligence, Gasification/IGCC, and Carbon Capture

Sandia National Laboratory, New Mexico, Summers 1992 and 1993. Summer Intern. - Performed inelastic finite element analysis on casks used to transport spent nuclear fuel.

Fleetguard, Inc., a Cummins Company, Tennessee, Summer and Fall 1989-1991. Co-op Engineer - Designed and tested oil, fuel, water, and air filters, including extensive CAD work.

SELECT PRESENTATIONS & PUBLICATIONS

Slettehaugh, Bob. “Revisiting the potential of carbon capture technologies.” Energy Capital – The Magazine. March-April 2021, Edition 02. Conference; Bismarck, North Dakota. January 2021.

Slettehaugh, Bob, Katie Satrom, “CO2 Transformation from Waste to Valuable Products.” Kiewit Technical Summit; On-line. February 2021.

Slettehaugh, Bob. “Beyond Petra Nova: the Next Generation of Carbon Capture in the US.” Energy Progress & Innovation Conference; Bismarck, North Dakota. January 2021.

Power-Gen International 2018; Orlando, Florida. December 2018. Co-chair of the clean coal track (was eliminated prior to the conference).

Slettehaugh, Robert A., Jason Abiecunas, Mike Soltys, Tim Hillman, Tom O’Brien, Kara Walker, Dale Lindberg. “New Generation Development Planning.” Power-Gen Asia 2014; Kuala Lumpur, Malaysia. August 2014.

Slettehaugh, Robert A., Brian Reinhart, Erwing Calleros. “System Approach to Flexible Power Generation: A Case Study.” Power-Gen International 2013; Orlando, Florida. November 2013.

Slettehaugh, Robert A., Brian Reinhart, Alap Shah, Mark Dittus, and Ken Nowling. “A Case Study on Coal to Natural gas Switch.” Power-Gen International 2012; Orlando, Florida. December 2012.

Slettehaugh, Robert A. “Comparison of CO2 Capture Costs for Coal Power Plants: What Scenarios Favor IGCC?” Gasification Technologies Conference 2009; Colorado Springs, Colorado. January 2009.

Slettehaugh, Robert A. “Carbon Capture and Other CO2 Reduction Options for Coal.” Infocast Carbon Capture Status & Outlook Meeting; Houston, Texas. January 2008.

Slettehaugh, Robert A. “CO2 Capture in Coal-Based IGCC Plants.” Plains CO2 Reduction Partnership Annual Meeting and Workshops; Maple Grove, Minnesota. January 2008.

Slettehaugh, Robert A. “A Comparison of IGCC Versus Supercritical PC: 2007 Update.” COAL-GEN 2007; Milwaukee, Wisconsin. January 2007.

ALAN DONOVAN

PROJECT MANAGER

EDUCATION

B.S. OF MECHANICAL ENGINEERING, UNIVERSITY OF KANSAS, LAWERENCE, KS, 2008

YEARS OF EXPERIENCE

Total Years in Industry: 13 years

Year Started at Company:

PROFESSIONAL REGISTRATIONS:

KS, TX, PA, LA

PROFESSIONAL ASSOCIATIONS:

American Society of Mechanical Engineers

PROFESSIONAL EXPERIENCE

Alan has participated in various responsibilities of project completion, including management, cost estimating, detailed system design, equipment procurement and contract administration. Alan has managed multiple carbon capture FEED studies, was the responsible engineer leading the mechanical design team on a 5x2 power island for an LNG facility, and was the responsible engineer leading the mechanical team on a first of a kind, high-ethane blend combustion turbine project. Alan also has approximately two years of onsite field engineering experience.

SELECT KIEWIT & AFFILIATES PROJECT EXPERIENCE

Project Manager, Estimate Manager, Prairie State Generating Center – Carbon Capture FEED, Prairie State Generating Co., Marissa, IL

Alan was responsible for the overall engineering team in the design and execution of the full-scale Front-End Engineering Design (FEED) study for the project. He participated in client meetings, constructability meetings, project monthly reporting, DOE reporting and schedule progress. After the FEED study was complete, Alan was the estimate manager responsible for the estimate team during a full bottoms-up detailed estimate. He participated in client meetings, executive leadership reviews, reporting and schedule progress.

The FEED study was for an 816 MWe (8.4 MTPA) carbon capture plant at the coal-fired Prairie State Generating Center using Mitsubishi Heavy Industries America technology and their Advanced KM CDR Process™.

Project Manager, Confidential Carbon Capture Project FEED, TX

Alan was responsible for the overall engineering team in the design and execution of the Front-End Engineering Design (FEED) study for the project. He participated in client meetings, constructability meetings, project monthly reporting and schedule progress.

The FEED study was for a 2.5 MTPA Carbon Capture Plant on a natural gas power plant using Mitsubishi Heavy Industries America technology and their Advanced KM CDR Process™.

Project Manager, Confidential Carbon Capture Project Feasibility, Edmonton, Alberta, Canada

Alan was responsible for the overall engineering team in the design and execution of the Feasibility study for the project. He participated in client meetings, constructability meetings, project monthly reporting and schedule progress.

The Feasibility study was for a 1.0 MTPA Carbon Capture Plant on a cement facility using Mitsubishi Heavy Industries America technology and their KM CDR Process™.

Project Manager, Various Confidential Carbon Capture Project Cost

ALAN DONOVAN
PROJECT MANAGER

Studies

Alan was responsible for multiple FEL-2 level development and costing studies with Mitsubishi Heavy Industries America technology utilizing their KM CDR Process™.

Project Manager, Plaquemines LNG – Power Island Early Work Activities, Venture Global LNG, Plaquemines Parish, LA

Alan was responsible for the power island engineering team in the design and execution of early works activities to progress permitting and detailed cost estimates. Responsibilities included scheduling, budgeting, and staffing, while coordinating with the Kiewit process team designing the LNG facility.

The power island portion of the project was two separate, nearly identical combined-cycle power plants each consisting of five GE 7EA combustion turbines cross-tied with two GE/Alstom steam turbines and two Air Cooled Condensers.

Lead Mechanical Engineer, Calcasieu Pass LNG – Power Island, Venture Global LNG, Cameron Parish, LA

Alan was responsible for scheduling, budgeting, and staffing the mechanical design team while providing technical direction and coordination for all equipment procurement and system design. Alan was also responsible for coordinating with the Kiewit process team members designing the LNG facility.

The power island portion of the project was a combined-cycle power plant consisting of five GE 7EA combustion turbines cross-tied with two GE/Alstom steam turbines and two Evapco Air Cooled Condensers. Kiewit was awarded the detailed design, procurement, construction, and startup of the entire LNG facility.

Lead Mechanical Engineer, Engineering Manager, Fairview Energy Center, Competitive Power Ventures, Jackson Township, PA

Alan was responsible for scheduling, budgeting, and staffing the mechanical design team while providing technical direction and coordination for all equipment procurement and system design. Being a first of a kind high ethane blend fired combustion turbine, Alan was heavily involved in the coordination and design of the ethane supply and vaporization systems. Alan later transitioned to the Engineering Manager responsible for all engineering disciplines, client interface, and reporting.

The project was a 1,050 MW plant tri-fuel (natural gas, natural gas/ethane blend, fuel oil ready), combined-cycle power plant with two GE 7HA.02 combustion turbine generators, two CMI Energy heat recovery steam generators, and a GE/Alstom D602 condensing steam turbine. Kiewit was awarded the detailed design, procurement, construction, and startup of the project.

Senior Design Engineer, Grand River Energy Center, Associated Electric Cooperative, Inc., Chouteau, OK

Alan was responsible for providing reviews of all critical system design and control philosophies ensuring proper system operation throughout all normal and abnormal operating scenarios. He worked with the startup team for proper controls, set points and to incorporate lessons learned to minimize commissioning time. He also provided support to the field team and management for challenging issues.

The project was a 520 MW plant natural gas-fired, combined-cycle power plant with two Siemens V84.3A2 combustion turbine generators, two Vogt NEM heat recovery steam generators and a Siemens

KN condensing steam turbine. Kiewit was awarded the detailed design, procurement, construction, and startup of the project.

Senior Design Engineer, Woodbridge Energy Center, CPV, Woodbridge, New Jersey

Alan provided warranty support and troubleshooting for systems not operating as designed. He worked onsite with plant operations to facilitate system diagnosis and pump testing while the plant remained online.

The project was a 700 MW natural gas-fired, combined-cycle power project with two GE 7FA.05 turbines, one GE steam turbine, two heat recovery steam generators and a wet cooling tower. Kiewit was awarded the detailed design, procurement, construction, and startup of the project.

Senior Design Engineer, Homer City Units 1&2 AQCS Project, EFS Homer City, Homer City, PA

Alan was responsible for providing reviews of system design, operation, and testing procedures. He also provided support to the field team and management for challenging issues.

The project was to engineer, procure, construct and startup the dry flue gas desulfurization (DFGD) system to an existing two-unit (620 MW each) power plant. The project used an Alstom fabric/filter novel integration desulfurization (NID) system consisting of two fabric filter buildings to remove emission particulate.

Senior Design Engineer, Pio Pico Energy Center, San Diego County, CA

Alan was responsible for providing reviews of fuel gas system design and control philosophies ensuring proper system operation throughout all normal and abnormal operating scenarios. He worked with the team to add fuel gas regulation after the plant was operational and the fuel gas source constraints were revised.

The project was a 300 MW, natural gas-fired simple cycle facility using three GE LMS100 combustion turbines. Kiewit was awarded the detailed design, procurement, construction, and startup of the project.

Systems Design Engineer, Cherokee Combined Cycle Project, Excel Energy, Denver, CO

Alan was involved with the design of system piping and instrument diagrams including the blowdown system, auxiliary steam system, fuel gas, miscellaneous combustion turbine piping systems, demineralized water, plant/waste drains and plant air systems. He provided all supporting system calculations including the blowdown header and tank sizing, control valves and de-superheaters. Procurement activities included the fuel gas regulation station, fuel gas conditioning equipment, general service pumps, all low-pressure valves and specialty equipment, and managed the GE technical contracts.

The nominal 600 MW combined cycle plant consisted of two GE 7FA.05 combustion turbines with Nooter-Eriksen heat recovery steam generators, and a grey-market GE D11 steam turbine with a cooling tower. Kiewit was awarded the detailed design, procurement, construction, and startup of the project.

Systems Design Engineer, Lead Field Engineer, Lead Process Engineer, Brayton Point Closed Loop Cooling Project, Dominion Energy, Somerset, MA

Alan served as a System Design Engineer eventually becoming Lead Process Engineer, Lead Field Engineer and performed Lead Mechanical Engineering responsibilities. He designed system piping and instrument diagrams, performed system design calculations, prepared equipment specifications, administered critical and non-critical contracts up to $15 million and provided onsite project closeout

activities such as conflict resolution, conformed construction documentation, weekly owners meetings and start-up of all systems.

The project was an existing 1,600 MW Coal Plant cooling water conversion from open cycle to closed cycle with two natural draft cooling towers and four cooling tower supply pumps rated at 180,000 gpm at 84 ft. each. Engineering services provided for this project included system design, retrofitting a cooling system for the existing coolers, historical weather analysis, permit limitation analysis, and System Design Specifications. Kiewit was awarded the detailed design, procurement, construction, and startup of the project.

PREVIOUS EXPERIENCE:

Lead Field Engineer, Parsons Brinckerhoff, Garrison Energy Center, Calpine, Dover, DE

Alan was the Project Field Engineer for the Garrison Energy Center, which was a 309 MW combined cycle power plant that utilized one GE 7FA combustion turbine with a .04 upgrade, a Nooter-Eriksen heat recovery steam generator, and one GE A10 axial exhaust team turbine. Alan provided onsite engineering support during construction, coordinated piping fabrication and deliveries, created site processes including construction as-built procedures, and created construction packages including pipe fabrications, pipe installation, insulation supply and installation, and painting and coatings.

BRYAN LOFGREEN

LEAD MECHANICAL ENGINEER

EDUCATION

Masters, Science, Mechanical Engineering, University of Missouri-Kansas City - 2011

Bachelors of Science, Mechanical & Aerospace Engineering, University of Missouri - Columbia - 2006

YEARS OF EXPERIENCE

Total Years in Industry: 15 years

Year Started at Company: 2010

PROFESSIONAL EXPERIENCE

Bryan has been with Kiewit since 2010 and brings over a decade worth of experience as a mechanical engineer to the project delivery team. As the lead mechanical engineer, he leverages his technical knowledge and leadership skills to review all mechanical designs and subcontractors for compliance and to mentor the engineering staff throughout the project delivery lifecycle. Bryan is usually the client and subcontractor main point of contact because of his unique ability to effectively compartmentalize and communicate project delivery milestones.

CAREER SUMMARY		
ROLE	**LOCATION**	**YEARS**
Mechanical Lead	Lenexa, KS	2011 - Present

SELECT KIEWIT & AFFILIATES PROJECT EXPERIENCE

Lead Mechanical Engineer, Prairie State Carbon Capture Retrofit FEED, University of Illinois, Marissa, IL (2020-2021)

Full-scale front-end engineering design study for an 8.4 MTPA (816 MWe) capture plant using Mitsubishi Heavy Industries America technology and their Advanced KM CDR Process.

Lead Mechanical Engineer, Confidential Carbon Capture Project FEED, TX (2020-2021)

The FEED study was for a 2.5 MTPA Carbon Capture Plant on a natural gas power plant using Mitsubishi Heavy Industries America technology and their Advanced KM CDR Process™.

Lead Mechanical Engineer, Midwest AgEnergy, Blue Flint Ethanol Carbon Capture, ND (2020)

Completed a Pre-FEED on existing ethanol plant to capture and compress approximately 180,000 tonne/yr as part of Midwest AgEnergy's CarbonZero initiative. Scope included process design, equipment selection, site layout, heat and material balances, as well as capital cost estimate and project schedule.

Lead Mechanical Engineer, Naheola Tissue Paper Machine Number 8 Pile Project, TIC Denver, Pennington, AL (2019-2020)

Installed secants, drilled shafts and auger cast piles for the Naheola Tissue Paper Machine Number Eight Project.

Lead Mechanical Engineer, Naheola Mill Biomass Engineering Project, TIC - The Industrial Company, Pennington, AL (2017-2018)

Engineered a 550,000 pound per-hour (pph) biomass-fueled boiler, new baghouse, ash storage and handling equipment (pneumatic with sand reclaim system), steam surface condenser, boiler feedwater pumps and biomass fuel yard.

BRYAN LOFGREEN

LEAD MECHANICAL ENGINEER

Lead Mechanical Engineer, Petra Nova Carbon Capture Project, Petra Nova, Thompsons, TX (2014-2017)

Petra Nova selected TIC – The Industrial Company and Mitsubishi Heavy Industries America (MHIA) to engineer, procure and construct the 5,200-ton-per-day carbon-capture project at the W.A. Parish site. MHIA was responsible for the detailed design and supply of the carbon capture facility, Kiewit Engineering Group Inc. (KEGI) had ownership of the detailed design and supply of the balance-of-plant, and TIC is responsible for all construction on the project.

Mechanical Engineer, Sutton Combined-Cycle Plant, Progress Energy, Wilmington, NC (2010-2012)

Responsible for the engineering, procurement and construction of the new 625 MW combined-cycle power plant. Project equipment included two Siemens 5000F combustion turbine generators, two Vogt triple-pressure heat recovery steam generators and a Toshiba 285 MW steam turbine generator.

Mechanical Engineer, Wayne County 3x1 Combined Cycle Power Plant -102"Circ. Water Pipeline, Progress Energy, Goldsboro, NC (2010-2012)

After decommissioning four oil-fueled combustion turbines and three coal-fired units, Duke Energy built a new 950-MW combined-cycle power plant featuring three 206-MW Siemens 5000F combustion turbine generators (CTG), three Vogt triple-pressure heat recovery steam generators (HRSG), and a 400-MW Toshiba steam turbine generator (STG). The new plant works in tandem with five existing combustion turbines to provide 1,783 MW of peaking power to surrounding areas – while significantly reducing site emissions. As part of a JV with TIC, WSCI constructed the intake and outfall structures, filter press building, and support facilities. This included dual 102-in. prestressed concrete cylinder pipe (PCCP) cooling water lines buried from the STG condenser to the Neuse River Canal, then transitioning to exposed pipe in an aerial crossing with self-supporting dual 102-in. steel pipelines spanning nearly 180 ft. After crossing, the lines continue on an elevated rack for 350 ft. before tying into the intake and outfall structures. WSCI played an important role in overall project safety, scheduling, planning, and management, as well as scope items including concrete, HRSG installation and testing, and a new fire water loop. This project was recognized as ASCE 2012 Pipeline Project of the Year.

PREVIOUS EXPERIENCE

Mechanical Engineer, Sierra SunTower Project, Lancaster, CA (2008-2009)

Sierra SunTower Project is a five MW Solar Test Plant and won 2009 Power Engineering Renewable Project of the Year.

Bryan was responsible for developing plant P&IDs. In addition, he assisted with development of plant layout, pipe routing/supports and instrumentation.

Mechanical Engineer, Victoria Repowering Project, Victoria, TX (2007-2008)

Victoria Repowering Project is a 330 MW MHI 50F Gas Turbine with a Vogt Heat Recovery Steam Generator coupled with an existing GE Steam Turbine.

Bryan was responsible for the development of plant P&IDs. He assisted with development of plant layout, pipe routing/supports and instrumentation and interfaced with vendors through the processes of equipment selection, specification, and integration into plant design.

APPENDIX E

BUDGET NOTES

BUDGET NOTES
ENERGY & ENVIRONMENTAL RESEARCH CENTER (EERC)

BACKGROUND

The EERC is an independently organized multidisciplinary research center within the University of North Dakota (UND). The EERC is funded through federal and nonfederal grants, contracts, and other agreements. Although the EERC is not affiliated with any one academic department, university faculty may participate in a project, depending on the scope of work and expertise required to perform the project.

INTELLECTUAL PROPERTY

The applicable federal intellectual property (IP) regulations will govern any resulting research agreement(s). In the event that IP with the potential to generate revenue to which the EERC is entitled is developed under this project, such IP, including rights, title, interest, and obligations, may be transferred to the EERC Foundation, a separate legal entity.

BUDGET INFORMATION

The proposed work will be done on a cost-reimbursable basis. The distribution of costs between budget categories (labor, travel, supplies, equipment, etc.) and among funding sources of the same scope of work is for planning purposes only. The project manager may incur and allocate allowable project costs among the funding sources for this scope of work in accordance with Office of Management and Budget (OMB) Uniform Guidance 2 CFR 200.

Escalation of labor and EERC recharge center rates is incorporated into the budget when a project's duration extends beyond the university's current fiscal year (July 1 – June 30). Escalation is calculated by prorating an average annual increase over the anticipated life of the project.

The cost of this project is based on a specific start date indicated at the top of the EERC budget. Any delay in the start of this project may result in a budget increase. Budget category descriptions presented below are for informational purposes; some categories may not appear in the budget.

Salaries: Salary estimates are based on the scope of work and prior experience on projects of similar scope. The labor rate used for specifically identified personnel is the current hourly rate for that individual. The labor category rate is the average rate of a personnel group with similar job descriptions. Salary costs incurred are based on direct hourly effort on the project. Faculty who work on this project may be paid an amount over the normal base salary, creating an overload which is subject to limitation in accordance with university policy. As noted in the UND EERC Cost Accounting Standards Board Disclosure Statement, administrative salary and support costs which can be specifically identified to the project are direct-charged and not charged as facilities and administrative (F&A) costs. Costs for general support services such as contracts and IP, accounting, human resources, procurement, and clerical support of these functions are charged as F&A costs.

Fringe Benefits: Fringe benefits consist of two components which are budgeted as a percentage of direct labor. The first component is a fixed percentage approved annually by the UND cognizant audit agency, the Department of Health and Human Services. This portion of the rate covers vacation, holiday,

and sick leave (VSL) and is applied to direct labor for permanent staff eligible for VSL benefits. Only the actual approved rate will be charged to the project. The second component is estimated on the basis of historical data and is charged as actual expenses for items such as health, life, and unemployment insurance; social security; worker's compensation; and UND retirement contributions.

Travel: Travel may include site visits, fieldwork, meetings, and conferences. Travel costs are estimated and paid in accordance with OMB Uniform Guidance 2 CFR 200, Section 474, and UND travel policies, which can be found at http://und.edu/finance-operations (Policies & Procedures, A–Z Policy Index, Travel). Daily meal rates are based on U.S. General Services Administration (GSA) rates unless further limited by UND travel policies; other estimates such as airfare, lodging, ground transportation, and miscellaneous costs are based on a combination of historical costs and current market prices. Miscellaneous travel costs may include parking fees, Internet charges, long-distance phone, copies, faxes, shipping, and postage.

Equipment: Not applicable.

Supplies: Supplies include items and materials that are necessary for the research project and can be directly identified to the project. Supply and material estimates are based on prior experience with similar projects. Examples of supply items are chemicals, gases, glassware, nuts, bolts, piping, data storage, paper, memory, software, toner cartridges, maps, sample containers, minor equipment (value less than $5000), signage, safety items, subscriptions, books, and reference materials. General purpose office supplies (pencils, pens, paper clips, staples, Post-it notes, etc.) are included in the F&A cost.

Subcontractor – MHI – MHI will provide a front-end engineering and design study for the project to retrofit a postcombustion capture plant on each generating unit at Coal Creek Station. The estimated cost is $9,255,000 and is based on the attached quote.

Subcontractor – Burns & McDonnell – Burns & McDonnell will assist with the assessment of installing postcombustion CO_2 capture technology at the existing Coal Creek Station near Underwood, North Dakota. The estimated cost is $2,970,000 based on the attached quote.

Professional Fees: Not applicable.

Communications: Telephone, cell phone, and fax line charges are included in the F&A cost; however, direct project costs may include line charges at remote locations, long-distance telephone charges, postage, and other data or document transportation costs that can be directly identified to a project. Estimated costs are based on prior experience with similar projects.

Printing and Duplicating: Page rates are established annually by the university's duplicating center. Printing and duplicating costs are allocated to the appropriate funding source. Estimated costs are based on prior experience with similar projects.

Food: Expenditures for project partner meetings where the primary purpose is dissemination of technical information may include the cost of food. The project will not be charged for any costs exceeding the applicable GSA meal rate. EERC employees in attendance will not receive per diem reimbursement for meals that are paid by project funds. The estimated cost is based on the number and location of project partner meetings.

Professional Development: Fees are for memberships in technical areas directly related to work on this project. Technical journals and newsletters received as a result of a membership are used throughout the development and execution of the project by the research team.

Operating Fees: Operating fees generally include EERC recharge centers, outside laboratories, and freight.

EERC recharge center rates are established annually and approved by the university.

Laboratory and analytical recharge fees are charged on a per sample, hourly, or daily rate. Additionally, laboratory analyses may be performed outside of the university when necessary. The estimated cost is based on the test protocol required for the scope of work.

Graphics recharge fees are based on an hourly rate for production of such items as report figures, posters, and/or images for presentations, maps, schematics, Web site design, brochures, and photographs. The estimated cost is based on prior experience with similar projects.

Shop and operations recharge fees cover specific expenses related to the pilot plant and the required expertise of individuals who perform related activities. Fees may be incurred in the pilot plant, at remote locations, or in EERC laboratories whenever these particular skills are required. The rate includes such items as specialized safety training, personal safety items, fall protection harnesses and respirators, CPR certification, annual physicals, protective clothing/eyewear, research by-product disposal, equipment repairs, equipment safety inspections, and labor to direct these activities. The estimated cost is based on the number of hours budgeted for this group of individuals.

Engineering services recharge fees cover specific expenses related to retaining qualified and certified design and engineering personnel. The rate includes training to enhance skill sets and maintain certifications using Webinars and workshops. The rate also includes specialized safety training and related physicals. The estimated cost is based on the number of hours budgeted for this group of individuals.

EERC Technical Software fees are for use of Aspen modeling software. The estimated cost is based on prior experience with similar projects.

Geotech Firm – The geotech firm (TBD) will drill test holes to determine soil type and consistency to aid in foundation decisions.

Turbine Vendor – The turbine manufacturer (TBD) will analyze the steam turbine to determine the feasibility and optimize steam extraction and associated costs.

Facilities and Administrative Cost: The F&A rate proposed herein is approved by the U.S. Department of Health and Human Services and is applied to modified total direct costs (MTDC). MTDC is defined as total direct costs less individual capital expenditures, such as equipment or software costing $5000 or more with a useful life of greater than 1 year, as well as subawards in excess of the first $25,000 for each award.

Cost Share: Project partner Rainbow Energy will provide cost share in the form of cash and in-kind in the amounts of $6,767,400 and $765,200, respectively.

APPENDIX G

HISTORICAL FINANCIAL STATEMENTS

HISTORICAL FINANCIAL STATEMENTS

Rainbow Energy Center, LLC, is a newly formed affiliate of Rainbow Energy Marketing Corporation. Rainbow Energy Center is currently in the process of purchasing the Coal Creek Station and does not yet have the requested 5 years of historical financial statements for this appendix.